MAR 29 1911

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POWER

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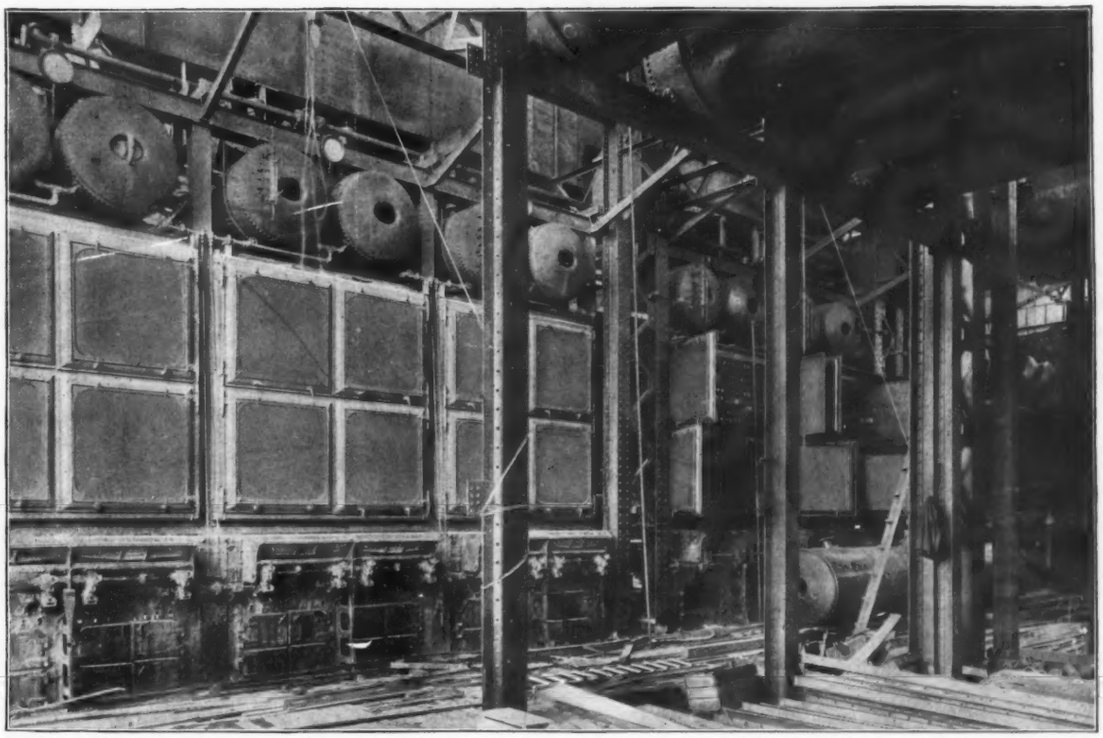

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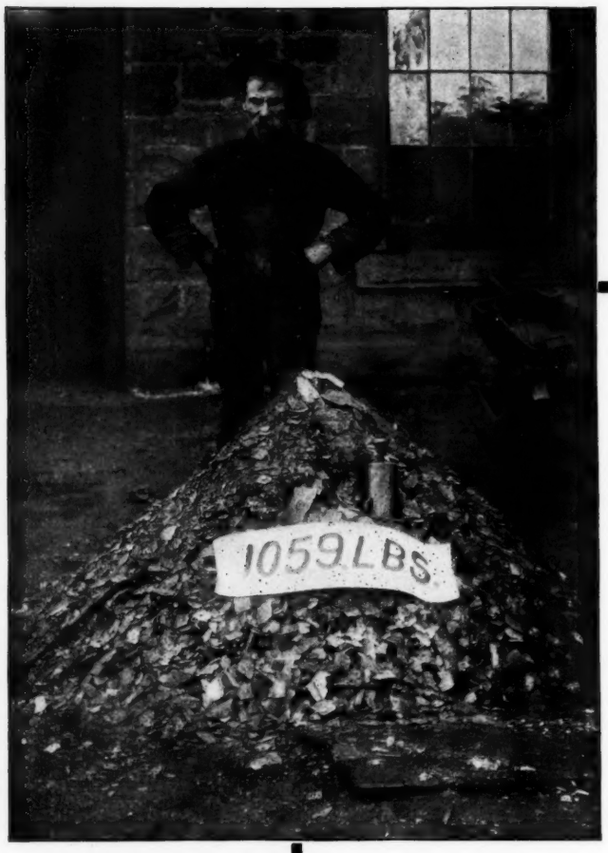


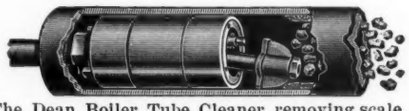
Pile of Scale
Removed by the Dean

This scale came from 2 boilers belonging to the A. T. & S. F. Ry. Co.'s power plant at Albuquerque, New Mexico. It shows how much scale may come from compound-cleaned boilers, for these boilers had previously been receiving "scientific" boiler compound treatment.

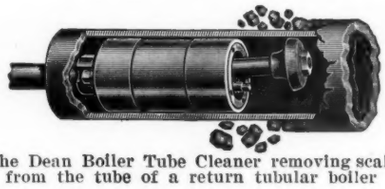
The chief engineer of the plant wrote us: "The Dean does everything you claim for it and pays for itself in a very short time."

Don't wait until your scale condition gets as bad as this—get a Dean and put an end to scale troubles.

Even if you remove only a quarter of the amount removed in this case, you'll save money.



The Dean Boiler Tube Cleaner removing scale from the tube of a water tube boiler



The Dean Boiler Tube Cleaner removing scale from the tube of a return tubular boiler

The Dean cleans the tubes clean—water tube or fire tube; and does the work in less time, with greater ease and at smaller cost than anything you could use for the purpose.

It is operated by air or steam and cleans 10 to 30 tubes an hour.

We want you to know just what it will accomplish before you even consider its purchase.

Let us send you one for free trial in one boiler—no obligations to purchase.

We'd like to send you our interesting booklet "Scale Removal Made Easy," anyway—write for it.

The Wm. B. Pierce Co.

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Buffalo, N. Y.

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POWER

NEW YORK, MARCH 28, 1911

"THERE ain't no chance these days for a fellow to get along" is the sentiment often expressed with the degree of grammatical accuracy quoted. And for the grown man who talks that way, usually there "ain't." But, truth to tell, these are wonderful times, and there are more opportunities than ever just going abegging for lack of men to see and make use of them.

If you cannot readily believe this, we half suspect that you are one of those who sing the refrain quoted in the opening sentence. Figure over the matter for a minute.

What were the engineer's opportunities 50 years ago? Pretty small and few in a hill, weren't they? Ignorance was rife; means for self-education were totally lacking; jobs were small; the engineer had absolutely no standing, and, worst of all, there was no incentive for him to improve himself even if he had the inclination. His life was a dull, dirty, colorless monotony.

Today, there is hardly any limit to the progress that the engineer can make, the field is so broad. There are positions for men of every caliber from the two-dollar to the twenty-dollar-a-day man. There are means easily within the reach of all, of fitting oneself for higher grade work; these are the correspondence schools, the engineers' periodicals, the countless good books and the associations—all can be made sure stepping stones by the man who *will*.

No one can "wish" himself well. A man must attain good health, once he has lost it, by careful diet, proper exercise and rest. So also with advancement; "wishing" that you had the other fellow's "cinch" is poor "nourishment." To reap the reward of better pay requires conscientious, hard work in increasing your ability and experience.

In steam engineering today, knowledge means ability. Professor Ennis made this quite clear by his lecture to the proposed Institute of Operating Engineers on March 9. The lecture is reproduced on page 485 herein. Many engineers have already found it to be true, and its truth is dawning on an ever increasing number as time goes on.

The men for the big jobs of the future are the men who are in training for them now. If a man is unprepared when his big chance comes, it is usually too late to start.

Knowledge will not do anyone harm, even if it is never used. But how valuable it is when there is occasion to apply it!

There is great need for educated, capable men in the steam-engineering field, and that need is constantly growing. There are opportunities, open to all, to acquire education of the kind needed. The wise ones are making use of them.

If you are not thoroughly thankful that you are alive and well and kickin' on this day of grace and exceptional opportunity, it probably is because you need to see a doctor and don't know it.

Power Plant at North Carolina College

By Francis J. Thompson

A small central plant containing a De Laval turbine unit and an engine-driven unit, supplying light and power to the various buildings and heating them with the exhaust steam.

The various buildings of the North Carolina College of Agriculture and Mechanic Arts are supplied with heat, light and power from a central service station situated on the campus. The plant, although having a capacity of only 200 kilowatts, contains many interesting features for one of its size.

Steam is furnished by two 200-horsepower Atlas boilers and two 75-horsepower Babcock & Wilcox boilers (see Fig. 1), working under a normal pressure of about 125 pounds, the pressure being controlled by a damper regulator. Natural draft of about 0.5 is furnished by a 100-foot radial brick stack. A spur track from the Seaboard Air Line railroad runs in front of the boiler room and coal is dumped from the cars into concrete pockets having a capacity of 300 tons. These are in front of the boilers and may be shut off from the boiler room by corrugated-iron drop curtains.

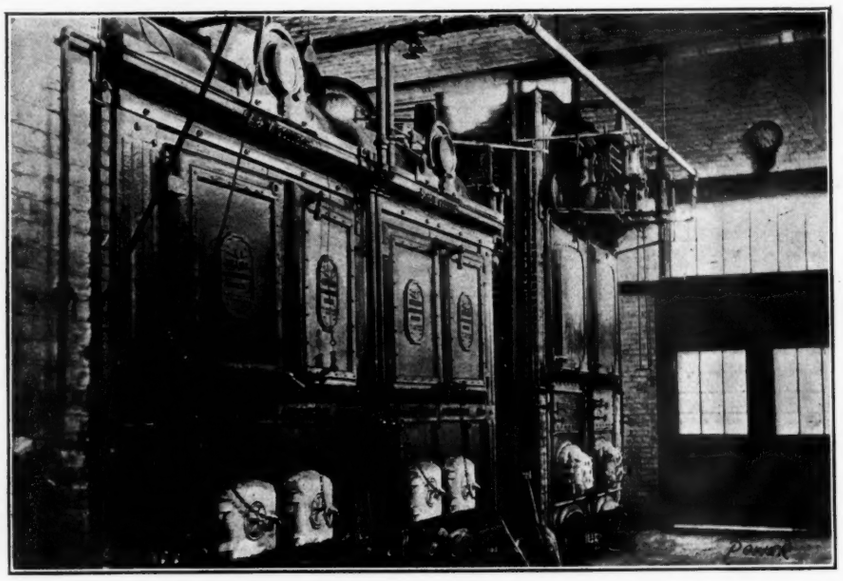


FIG. 1. BOILERS

Next to the boiler room, and separated from it by a brick fire wall, is the pump room. This is several feet lower than the engine room and, on one side, is open to the latter, as may be seen from Fig. 2. A 10-inch main leads from the boilers to a header running the length of the pump room and from this header long-radius bends branch off to the steam receivers placed above the throttles of the engines. Van Stone joints are used on all high-pressure lines and a notable feature of the station piping is its accessibility.

There are two main generating units: one consisting of a 13x12-inch Skinner engine direct connected to a three-phase 60-cycle generator of 75 kilovolt-amperes capacity; the other a 150-horsepower single-stage DeLaval turbine running at 12,000 revolutions per minute and geared through 10 to 1 reduction gears, to two three-phase 60-cycle generators. Owing to the high rotative speed of a single-stage turbine the shaft must be made small in diameter, and when transmitting horsepowers of from 50 to 300 it is the practice to supply two generators for the purpose of balancing the side thrust on the turbine shaft. Mounted on the shaft of one of these generators is an exciter. Two other exciter units are provided: one a motor-generator set, and the other a direct-current generator driven by a 5x5-inch vertical engine. Either of these two exciters may be used to supply excitation to the fields of either of the main generators.

A diagram of the switchboard connections is given in Fig. 3. From this it will be seen that common practice has been departed from by supplying an ammeter for each phase. A water rheostat is also furnished for supplying the maximum load when making experimental tests in connection with the courses of instruction. The normal load comprises the motors in the machine shop, forge shop, laboratories and textile mill in addition to about 500 incandescent lamps.

The exhaust steam from the main units and auxiliaries is used to heat the various buildings on the campus through the Warren Webster system, operating at about 5 inches vacuum. This supplies approximately 40,000 square feet of radiation and the condensation is handled by two vacuum pumps delivering into a receiving tank from which the hot water flows by gravity to a Cochrane feed-water heater. Provision is made for supplying live steam to some of the buildings when the supply of exhaust steam is inadequate.

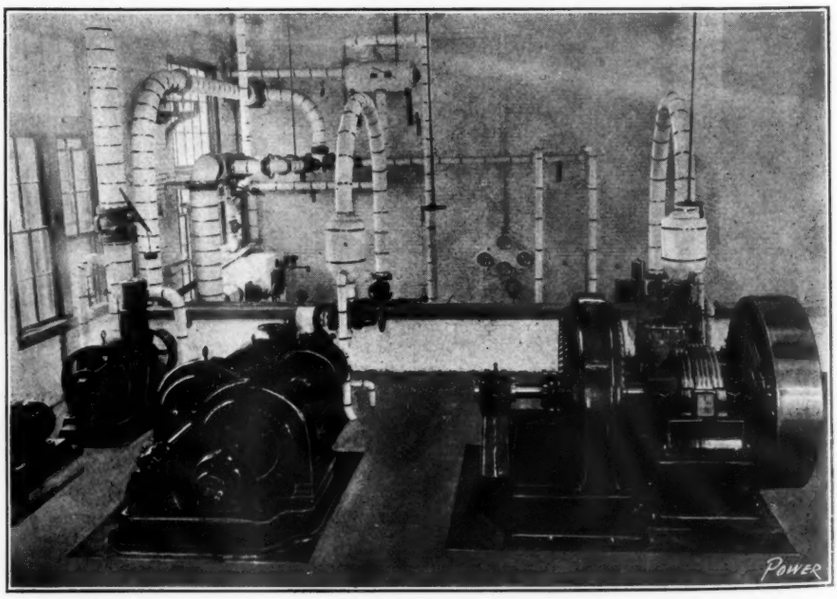


FIG. 2. MAIN GENERATING AND PIPING

Smoke Abatement in Glasgow and Liverpool

There are many who believe that the wisest and most hopeful method of attacking the black-smoke problem is by the education of those who have produced it, and that the further education of manufacturers and factory owners, of boiler engineers and firemen and, last but not least, of the ordinary householder is required before any real and permanent progress can be made in suppressing the black-smoke evil.

Those of our readers who accept this view will be pleased to learn that Glasgow and Liverpool have this winter followed the lead set by London three years ago, and have instituted courses of lectures for the general public and for boiler engineers and firemen upon smoke abatement.

At Glasgow the lead has been taken by the newly formed local branch of the Glasgow and West of Scotland Smoke Abatement League, and it is interesting to note that the municipality has allied itself with this body in providing two really useful and attractive courses of evening lectures: the one series intended for working boiler engineers and firemen, and the other for the general public.

The series of lectures for firemen consists of five similar courses, each of twelve lectures, delivered by the Glasgow smoke inspectors, in different centers of the working-class portions of the city, a fee of $1.25 being charged for the course. The education authorities have granted the use of suitably situated elementary schools for these lectures, and it is stated that 186 firemen and engineers have registered their names as students at one or other of the various centers, and are now attending the courses. In the majority of cases the employers have paid the fee and have urged the men to attend regularly.

The series of lectures for the general public in Glasgow is free, and is made attractive by the aid of lime-light views and experiments. The lectures are being delivered in the large hall of the technical school by several gentlemen connected with the health and medical departments of the university and city, and cover such subjects as: "The Black Smoke Problem," "The Necessity of Pure Air," "The Chemistry of Combustion," "How to Fire Steam Boilers without Smoke," etc.

In Liverpool, the school of hygiene department of the university, and the sanitary-science instruction committee of the corporation have combined to arrange a course of six evening lectures at the school of hygiene on "The Smoke Nuisance and Its Abatement."

The course is intended primarily for working engineers and firemen but all interested in the general subject of smoke abatement are invited to attend, and, as at Glasgow, a nominal fee of $1.25 is being charged for the course.

Professor Watkinson, of the Walker Engineering Laboratories, Doctor Hawksley, of the medical offices of the health department, J. B. C. Kershaw, of the West Lancashire Laboratory, Waterloo, and Mr. McAulay, the city smoke inspector, are delivering the various lectures of the course, which commenced on January 27 and has been continued on Friday evenings through February. It is hoped that the series now started will be the forerunner of similar lecture courses every winter in the leading seaport of the north of England.

The municipalities of Manchester, Sheffield, Birmingham, Leeds and other large inland manufacturing cities, with atmospheres certainly capable of improvement—might note the progressive action of the two northern seaports—and might make arrangements for instituting similar courses of lectures in their own cities next winter.

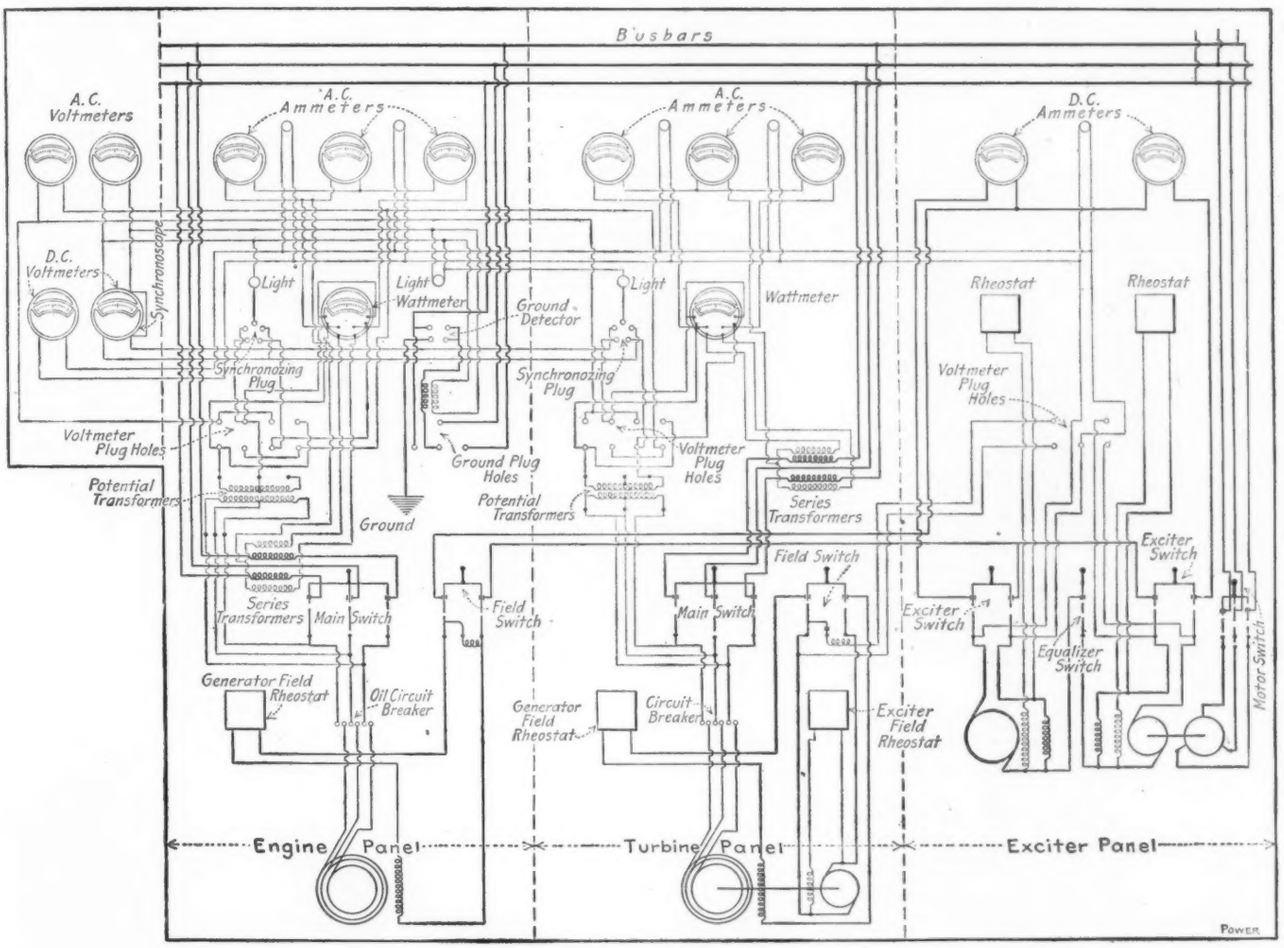


FIG. 3. DIAGRAM OF WIRING CONNECTIONS

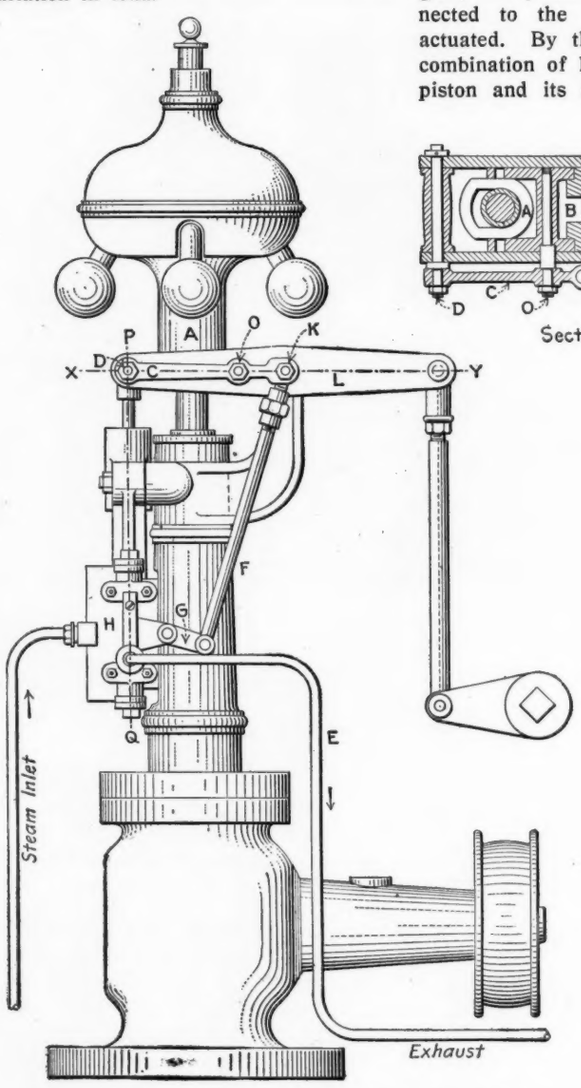
Methods of Governing Steam Engines

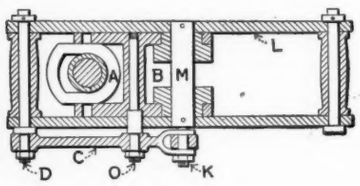
By John Davidson

Operation of governors controlled through relay motors, regulators or supplementary governors, safety trip gears, and crank shaft governors, representing standard English makes.

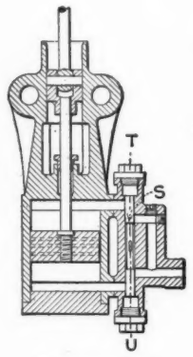
Governors Controlled through Relay Motors

Where the governor of a steam engine is required to actuate a heavy valve gear, it is difficult to obtain sufficient power, combined with sensitiveness in the governor itself, unless it be made of massive proportions; even then the friction and wear of the governor renders it an unsatisfactory piece of mechanism. Such valve gears as the Meyer and Ryder are included in this class. The gears themselves are positive, and are suitable for engines running at all speeds, but considerable force is required to move the gear to suit the variation in load.





Section X-Y.



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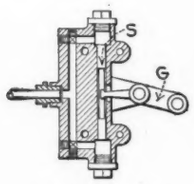


Section T-U.

FIG. 30. LUDE RELAY GEAR

Among the many appliances used in connection with governors as a relay gear, that invented by Lude many years ago and illustrated in Fig. 30, is perhaps the simplest in general use. With this arrangement, the only work done by the governor proper consists in controlling the piston valve of a miniature steam engine, the piston rod of which is connected to the expansion gear to be actuated. By the use of an ingenious combination of levers the motion of the piston and its connections is made to correspond with that of the governor, and, even with a very slight variation in load, the piston moves over a corresponding distance under the full steam pressure.

Referring to Fig. 30, the motion of the governor sleeve *A* is transmitted by means of the double lever *B*, to the lever *C* which is pivoted at *D* to the main lever *L*. The short arm of the lever *C* is connected by means of the rod *F* to a small lever *G* which actuates a small piston valve arranged in the casing *H* at one side of the steam cylinder. This valve controls the steam admission and exhaust ports of both ends of the cylinder. The arrangement is such that both sides of the piston are connected with the exhaust pipe when the valve occupies its central position, while a small movement of the valve in either direction will admit steam at one end of the cylinder. The resulting motion of the main piston rod and lever *L*, with its connections, causes the piston valve to return to its central position so as to again open both sides of the piston to the exhaust pipe, when the lever *L* has been turned through an angle corresponding to the movement of the governor sleeve. Normally, the center of the joint *K* corresponds with the turning axis *M* of the lever *L*. When the governor sleeve is moved the lever *C* is caused to turn about the center *D*, thereby raising or lowering the center *K*. The resulting movement of the lever *L* causes the lever *C* to turn about the center *O* and the center *K* is consequently returned into line with the axis *M* of the main lever *L*. As the steam flows at a high velocity the movement of the lever *L* is practically simultaneous with the movement of the governor sleeve.

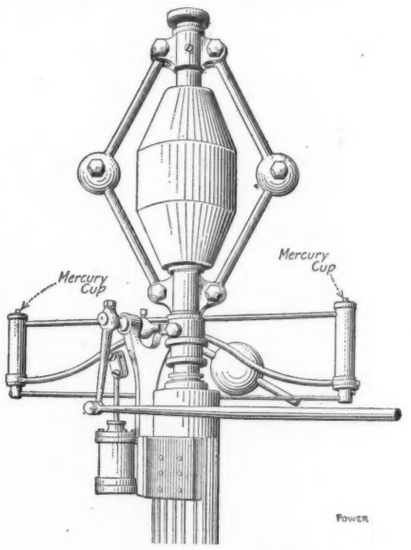


FIG. 31. HIGGINSON REGULATOR

Regulators or Supplementary Governors

With the ordinary type of governor it is impossible to keep the speed of the engine constant if the load or the steam pressure varies, because the governor cannot effect any change in the valve

gear or pressure of the steam admitted to the engine until a change in speed has actually taken place. To obviate this defect, supplementary governors or regulators are used.

There are many designs of regulators in general use, more particularly in connection with engines driving cotton mills, etc., where it is necessary to maintain a constant speed. One of the oldest and perhaps most largely used of these is the Higginson regulator, illustrated in Fig. 31, which automatically balances the governor in whatever position it assumes to correspond to a variation in the load or steam pressure. This is effected by altering the level of mercury contained in the two cylinders at the ends of the arms which form the regulator, these being originally attached to the governor rocking ring. The mercury cups are connected by a pipe, and the weight of mercury at each end of the regulator depends upon its angular position, the cylinders being accurately proportioned to the governor. This regulator answers exceedingly well for mills where the

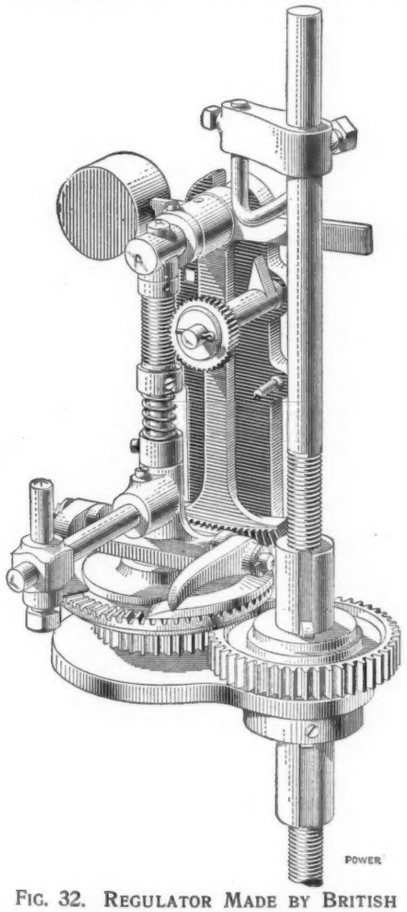


FIG. 32. REGULATOR MADE BY BRITISH METALLIC PACKING COMPANY

variation in load or steam pressure does not take place rapidly.

Another regulator, made by the British Metallic Packing Company, is shown in Fig. 32. The two parts of the governor rod, one with a right-hand thread and the other with a left-hand thread, are joined together by a sleeve. If this sleeve is revolved, the governor rod is lengthened or shortened according to the direction in which it is turned, and alters the valve motion, to give more or less steam to the engine as required. The governor-rod sleeve is rotated by means of a gear wheel, the sleeve sliding through the wheel and rising or falling in the usual manner, quite independent of the wheel. The sleeve wheel meshes with another wheel which is mounted on an upright spindle, and on the top of the latter wheel is a plate which has teeth on its upper face. Over this tooth-faced wheel is a movable shield plate which has a portion cut away so as to uncover a number of teeth on the face wheel, and over the shield plate is placed a pawl carrier actuated from some suitable moving part of the engine, the pawls riding on the shield plate. At the top of the bracket is pivoted a three-armed lever,

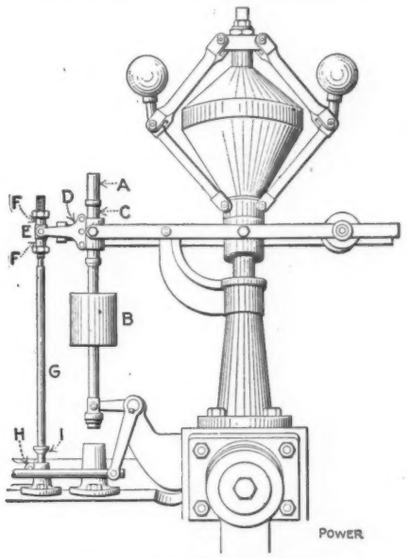


FIG. 33. SPEEDER GEAR

two of the arms being horizontal and the other vertical; the bottom end of the latter is provided with teeth which mesh into teeth formed on the shield plate. The illustration shows the pawls in the center of their travel, which ends when the pawls drop into the teeth of the face wheel.

The governor rod is shown at its normal hight, and one horizontal arm of the lever is held in firm contact with it by means of a weight on the other horizontal arm. It is evident that if the governor rises or falls the T-lever follows it and at the same time moves the shield plate and uncovers one or more teeth to be moved by the pawls. The action of the T-lever is very sensitive, about 1/16 inch rise or fall of the governor uncovering one tooth on the face wheel. The spindle revolves with the face wheel and carries a worm which meshes with a gear, automatically throwing the regulator out of action at any predetermined position.

A special feature of the regulator is that the two spur wheels can be changed, or any other wheels put on so as to obtain the exact speed of regulation suitable for the engine to which it is fixed.

SAFETY TRIP GEARS

Safety trip gears are generally fitted

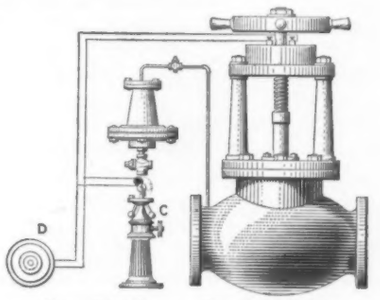


FIG. 34. TATES ELECTRIC STOP

to all engines where the governor is driven through intermediate gearing, such as a belt or ropes. By this means, should the belt or ropes break, or should they be carried away on account of some portion of the engine itself breaking, the steam is immediately cut off. In addition to this, the engine is immediately shut down should the speed exceed any predetermined amount.

A type of speeder gear used in connection with Porter, Proell and similar types of governors controlling trip gears of Corliss and drop-valve engines is illustrated in Fig. 33. Rod *A*, forming the connection between the governor and the valve gear, is weighted by the pot *B* so as to slide in the bush *C* should the catch *D* be released. This takes place whenever the block between the ends of the pair of tee-shaped levers *E* comes into contact with the nuts *F F* on the trip rod *G*. These nuts are adjusted so as to come into action during about the last ½ inch of movement of the governor at both top and bottom. The tripping rod *G* rests on the top of the engine frame, and is prevented from lifting by the hinged quadrant *H*, engaging with a collar on the end of the rod. To prevent the safety trip acting every time the engine stops, it is only necessary, just before shutting off steam, to turn the quadrant *H* until it catches under the collar *I* on the trip rod, the weight of the latter preventing the quadrant from falling. This allows the trip rod to lift when the engine stops and the governor falls, instead of releasing *D;* but in doing this it allows the quadrant *H* to drop. As soon as the engine starts again and the governor lifts, the trip rod *G* is lowered, and its bottom collar will again engage with the quadrant, thus automatically resetting the gear in its safe position. It will be seen that the gear, if properly adjusted, will act if the governor reaches its top position through overspeed, also, if the governor falls to the bottom through the failure of its driving gear, unless in-

tentionally prevented from doing so by the attendant propping the trip rod by means of the quadrant as described.

Another well known safety trip gear is the "Tates Electric Stop Motion," shown in Fig. 34. In this trip gear the main stop valve of the engine is closed by a powerful spring should the speed of the engine exceed any predetermined amount. In addition to this, if the engine is condensing, the vacuum is broken. Also, by means of suitable electrical connections the engine stop valve can be instantly closed from any part of the building by simply pressing a push button.

A small governor shown at *C* is driven by means of a belt from the engine shaft. If the engine runs at an excessive speed the tumbler at the top of the governor makes contact and the stop valve of the engine is immediately closed. If, however, the small belt driving this governor should break while the engine is running, the engine is instantly shut down.

Crank-shaft Governors

Governors of the crank shaft or drum

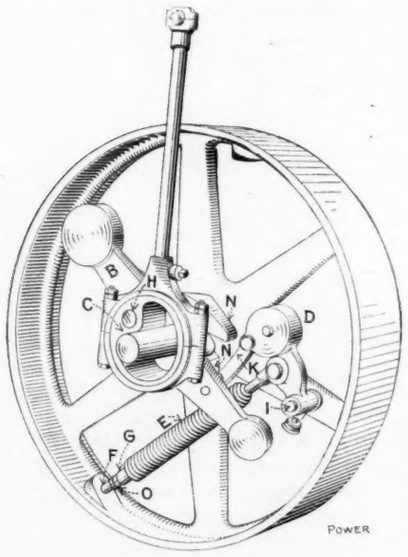


Fig. 35. Tangye Governor

type which control the speed of the engine by altering the travel and angle of the eccentric driving the valve, are not largely used in England. In the early days of high-speed engines, they were largely used and are still used by a few firms, but most makers of this class of engine have abandoned this type of governor and use the throttle type universally. For small engines, crank-shaft governors are very suitable, and a design of governor used by Messrs. Tangyes, of Birmingham, is illustrated in Fig. 35.

This governor consists of an inertia arm *B*, with which is cast the eccentric *C*, pivoted on the steel pin *H*, and free to swing within the limits provided by the stops *N N*. The weight box *D*, carried upon the pivot *I*, is connected to the governor arm by link *K*, and the spring *E* tends to pull the arm *B* against the stop *N*. When the direction of rotation is in a clockwise direction, the action of the governor is as follows: The weight *D* flies out radially when the wheel is rotated, and moves the governor arm by means of the link *K*. The inertia arm *B* lags behind, and assists the weight *D*

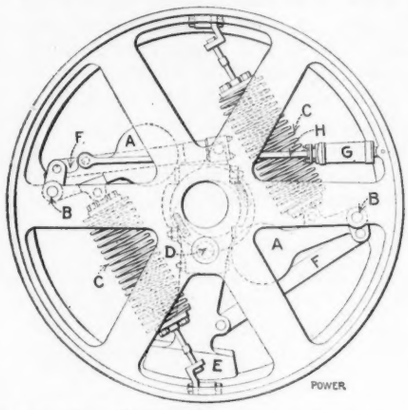


Fig. 36. Wilson-Hartnell Governor

either at an increase or a decrease of speed. This has the effect of either increasing or decreasing the travel of the eccentric and the cutoff of the equilibrium piston valve is adjusted to the required work. The eccentric in the position shown is at the maximum travel, such as when the engine is starting up. Upon the required speed being attained, the center of the eccentric moves toward the center of the shaft, and the travel of the valve is reduced. The weight box *D* contains loose weights secured by a cover plate and bolt; by removing one of the weights the speed of the engine is increased about five revolutions, and the entire number of weights gives a variation of about fifty revolutions. The required spring strength for best working is obtained by a plug in the spring *E*, which can be moved by the box spanners *G*. The position of this plug is secured by locknuts *O*.

A very powerful and at the same time sensitive type of crank-shaft governor is shown in Fig. 36, which is made by Messrs. Wilson, Hartnell & Co.

The two centrifugal weights *A A* pivoted at *B B* are restrained by the springs *C C*. The eccentric is pivoted at *D* and has a counterbalance weight fitted at *E*. The movement of the centrifugal weights is transmitted to the eccentric by the links *F* and the counterbalance for the eccentric at *E* makes the governor act partly as an inertia governor. A dashpot is fitted at *G* and is coupled to the centrifugal weight by the rod *H*. This is found necessary in order to resist the thrust of the eccentric.

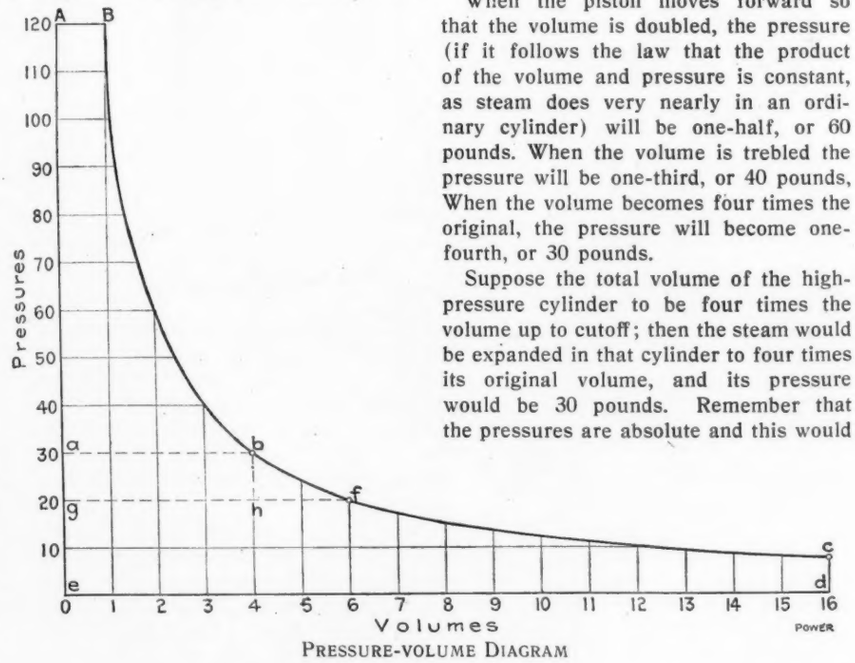
Effect of Low Pressure Cut-off on Compound Engine

A perplexed subscriber cannot understand how shortening the cutoff on the low-pressure cylinder makes that cylinder do more work.

In the diagram herewith, let the line *A B* represent the volume of steam in the high-pressure cylinder of a compound engine at the point of cutoff and the line *A O* represent its absolute pressure.

When the piston moves forward so that the volume is doubled, the pressure (if it follows the law that the product of the volume and pressure is constant, as steam does very nearly in an ordinary cylinder) will be one-half, or 60 pounds. When the volume is trebled the pressure will be one-third, or 40 pounds, When the volume becomes four times the original, the pressure will become one-fourth, or 30 pounds.

Suppose the total volume of the high-pressure cylinder to be four times the volume up to cutoff; then the steam would be expanded in that cylinder to four times its original volume, and its pressure would be 30 pounds. Remember that the pressures are absolute and this would



Pressure-volume Diagram

be the receiver pressure, about 15 pounds by the gage.

This steam is now discharged into the low-pressure cylinder, and if the volume of the low-pressure cylinder up to cutoff is just as much as the total volume of the high-pressure cylinder, this steam, neglecting resistances, will be simply transferred from one place to the other without change of volume or pressure The line *a b* will be the back pressure for

the high-pressure and the steam line of the low-pressure diagram.

Suppose now the steam to be again expanded four times in the low-pressure cylinder. The pressure would run down the curved expansion line shown, and at the end of the stroke the steam would have 16 times its original volume. It was expanded four times in the high-pressure cylinder and then this already expanded steam is expanded four times in the low-pressure cylinder, so that the total volume of the low-pressure cylinder must be 16 times that of the high up to cutoff. The terminal pressure will then be

$$120 \div 16 = 7.5 \textit{ pounds}$$

The low-pressure diagram will be *a b c d e* and the high-pressure diagram will be *A B b a*. Of course, there will be some back pressure above the absolute pressure line even with the condenser, but it is not material to the present argument.

Now suppose that the low-pressure cylinder cuts off at *f* instead of at *b*. It will take six of the original volumes out of the receiver at each stroke instead of four. But the high-pressure cylinder is delivering only four of these volumes, so that there will be a fall of pressure in the receiver to $\frac{4}{6}$ of 30 = 20 pounds.

The high-pressure diagram will now be *A B b h g;* and the low-pressure diagram *g f c d e.*

The lengthening of the low-pressure cutoff has, by reducing its initial pressure, taken the work represented by the area *a b f g* off from that cylinder; and by reducing the back pressure of the high, added the work represented by the area *a b h g* to that done by that cylinder. The energy represented by the triangle *b f h* is that of the free expansion in the receiver. It is not wholly lost, as it results in some drying of the receiver steam with a slight increase of its volume or pressure.

Locomotive Boiler Explosion

By C. L. Greer

The explosion, which occurred in Texas, killed nine men and injured twelve. Probable cause was defective gage and pop safety valve screwed down to the last thread.

An awful example of the destructive force of an exploding steam boiler was recently had in the explosion of a Missouri, Kansas & Texas locomotive boiler in the little town of Smithville, on the Colorado river, in Texas.

On February 8 a switch engine was brought from the shop after being thoroughly overhauled. While steaming up preparatory to a run to another town the boiler let go in one of the most disastrous explosions ever known. The wreck was so complete that it could not be ascertained at just what point the rupture first occurred. The whole firebox end of the engine was blown to pieces and the cab to splinters. A portion of the roof sheet of the firebox was hurled a distance of three blocks, landing in the street, while smaller pieces flew twice as far. This portion is shown in Fig. 5. One large piece crashed through the roof of a business house several blocks away. At some places the rivets were sheared completely while at others the sheets, ½ inch thick, were torn like paper.

Fig. 1 shows a general view of the wreck. The wrecked engine before the explosion stood between the two engines indicated by the arrows. When the explosion came the tender was thrown back into the turntable pit and the front part of the boiler was shoved forward a distance of about 100 feet, with the drivers plowing in the ground. The rear pair of drivers were shoved completely off

FIG. 1. SCENE OF LOCOMOTIVE BOILER EXPLOSION SHORTLY AFTER ACCIDENT OCCURRED

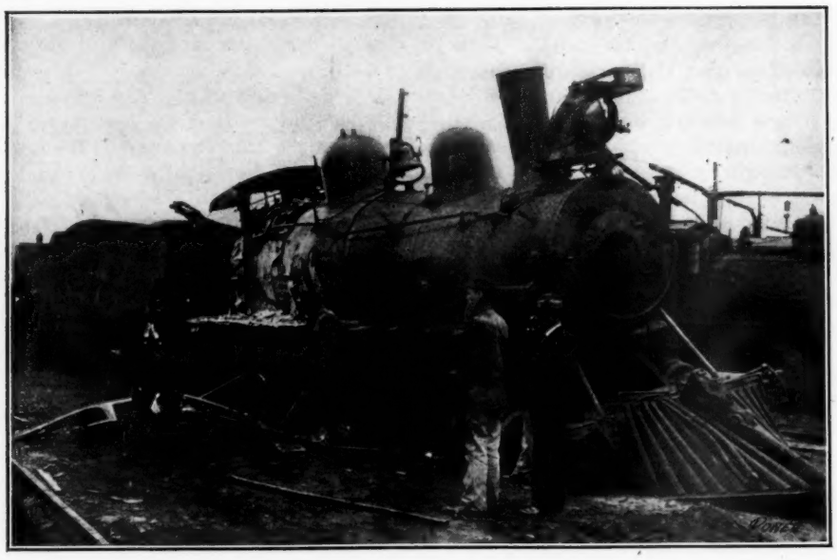


FIG. 4. THIS ENGINE DROPPED INTO PIT BELOW TRACK

the pit badly injured. Four bodies were taken from under this engine. Parts of human bodies were blown 600 feet away, rising high into the air.

It is the general opinion that the cause of the explosion was a defective steam gage. The man on the engine was setting the pop valve and it is thought the gage stuck when the pressure reached 155 pounds, as the gage stood at that point when found.

It is thought that the man screwed the pop valve down too tight and the gage failed to register the rising pressure. It is common report that when the pop safety valve was found it was screwed almost entirely down and when tested it took a pressure of 600 pounds to make it pop.

Parties who were near stated that before the explosion steam was issuing from under the jacket and apparently came from the seams, which were strained to the leaking point.

their axle, as shown in Fig. 2, and were dragged along by the connecting rods while the axle was bent to the arc of a circle. These wheels were pressed on their axle under a pressure of 90 tons. The two engines shown in Figs. 3 and 4, which stood on each side, were badly damaged, the cabs being almost entirely blown away. The engine shown in Fig. 4 was shoved off the track and dropped into the pit below while the rail on the far side was broken by the driving-wheel flange.

Fig. 5 shows how the braces and stay-bolts were broken and torn from the sheets. In Fig. 2 may be seen some of the sheared rivets still in the holes.

Nine men lost their lives and twelve were injured. Two men in the cab and one on top of the boiler were blown to atoms, being identified only by hands, feet and bits of clothing. A man working in the front end of the engine shown in Fig. 3 was unhurt, while one standing on the pilot of the same engine was found in

FIG. 5. AN ILLUSTRATION OF WHAT EXPLOSION DID TO STAYS AND BRACES

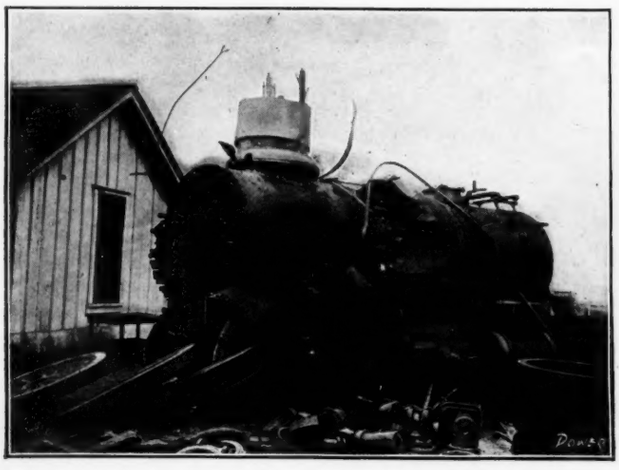


FIG. 2. FRONT PART OF WRECKED ENGINE

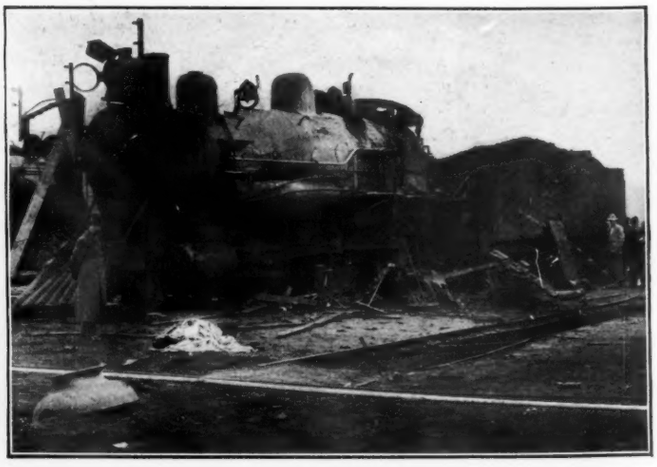


FIG. 3. DAMAGE TO ENGINE NEARBY

Operating Engineer's Opportunities*

By W. D. Ennis †

Factors upon which economical power generation depends: the engineer's part in determining them. Education is the instrument which the operating engineer must use to further his interests.

*Lecture to the proposed Institute of Operating Engineers at its second regular monthly meeting in New York on March 9.

†Professor of mechanical engineering in Polytechnic Institute, Brooklyn, and member of the proposed institute.

The wise manager endeavors to stop the big leaks first, to "hit the high spots." What are the "high spots" in power-plant engineering? It will probably be agreed that there are four fundamental considerations to be taken into account in any effort to produce cheap power. These are: first cost of the plant; the load factor; cost of the fuel, and the heat value of the fuel.

No sensible man would install stokers and economizers in a plant to be used as a water-power auxiliary for only a few hours in the year; the fixed charges on such equipment would offset any possible fuel saving. One would not expect to see the so called automatic type of engine in a pumping station running constantly at full load, because the high load factor there justifies making every reasonable effort to secure steam economy. The argument for a gas engine becomes weakened when good coal can be purchased for a dollar a ton, because the saving in fuel will not be sufficient in terms of dollars to offset the higher fixed and maintenance charges of the gas-engine plant. Power costs in western Washington are not greatly different from those in New York for the reason that, although coal there is poor in quality, it is cheap.

European engineers will scarcely build a large engine without jackets, because interest with them costs less, and fuel more than here.

It is said that the most economical rate of evaporation for a steam boiler is from 3 to 3½ pounds per hour, and perhaps it is, from a purely thermal standpoint; but if the plant has a one-hour overload of 100 per cent. twice a week, it may pay better occasionally to force up the evaporation rate to 6 or 9 pounds than to install more boilers.

The operating engineer today is a business manager, and he must not be a manager of that extinct type which became fossilized a generation ago. He must not work without tools and expect people to make allowances. Tools are available and people will *not* make allowances. Executive ability is what makes cheap steam. What we need is economics as well as thermodynamics.

You can judge an engineer's work by its results. Some may think that this is a handicap for the engineer. It is a good thing, not a bad thing. You cannot frighten a good man by "keeping tabs" on him. The more "tabs" you keep, the better he likes it.

It is probably safe to say that all the power in the world is obtained from heat, and the stock of heat in the universe is not unlimited. When we burn a ton of coal—in the everyday, ordinary steam plant—we utilize the heat of about 40 pounds of that coal. The rest we throw away. We do not know how long our coal will last—it may be a couple of centuries, it may be a thousand years—but the fuel is surely going. It may be said that in the nature of things we *must* waste the greater part of the coal, and, unfortunately, that is, for the present at least, true. But few ever reduce the waste to its irreducible minimum.

The first point of attack should be perhaps the fuel itself. What is available besides coal? What coals may be used that are now not commercially available? There are wood, fuel oil, natural gas, peat, and in certain places various waste-product fuels which will never concern most of us. A wood-working establishment may produce more refuse than is necessary for the making of all of the steam that the plant can use. One principal difficulty in using slabs, edgings and shavings in such plants is the great labor involved in firing. The products of the planer and saw are also apt to burn with much smoke. In some districts where lumbering is an important industry, the best engineer is the man who burns the most, not the least, fuel. Even when he does his best, there will be a rapid accumulation of refuse which must be incinerated in open burners running night and day, at no small fire hazard. It is not easy to sell this fuel to other steam users; it is too worthless to stand much transportation, and the supply is too irregular. In one Western plant the chips and shavings from a lumber mill were blown some 900 feet through a 14-inch pipe running along the beach to a flour mill, the nearest neighbor, where they were used for boiler fuel.

To burn good wood especially cut for fuel seems like a crime. A mill plant in the West burned 100 cords a day of splendid fir for several months in 1901, paying about $2 a cord. Wood is worth too much in that district now for any such application. California oil has replaced it. Fuel oil in New York costs more than twice as much per heat unit as ordinary coal, and it is impossible to think of using it for steam making. In western Washington, California oil at one cent per 72,000 B.t.u. has driven out both wood and coal at the same price, because the oil can be fired with less labor and greater economy. In San Francisco and other cities nearer the oil-fields the price of oil is much lower. This is fortunate, because in California other fuels are high in cost and the far-Western coals are mostly of poor quality.

As to natural gas, the problem is simple. Not long ago there was occasion for the writer to give advice regarding the installation of a gas engine in Pittsburg. The company owned a gas well of its own, but the pressure was irregular and the supply could not be depended upon. It was suggested that an engine be installed for natural gas—the necessary gas to be purchased—and that later on as natural gas became more expensive, the company could make its own producer gas to use in the same engine. But it was found that they could not hope to buy natural gas at a less cost, even at that time, than one cent per 80,000 B.t.u., whereas producer gas could be made at the rate of 100,000 B.t.u. for a cent. Even now, natural gas is a high-priced fuel for power purposes, and it should be. A fuel of that sort should be reserved for domestic consumption.

Engineering is constantly growing. The man who does things precedes the man who theorizes. Both types of man are useful. The steam engines of the eighteenth century were built without the help of thermodynamics, and they ran—some of them ran, some of the time—perhaps some are running yet. That wonderful engineer, James Watt—one of the most remarkable characters in engineering history—added as much theory as he could to much hard-bought experience and made the steam engine a practical machine. By the year 1835, pumping engines very nearly of the original Watt type are said to have developed a horsepower on about 1¾ pounds of coal per hour. There are pumping engines throughout the country at this moment not doing any better. The average steam engine does by no means as well. The very best engines will shade this figure only about 50 per cent., and few of us have ever seen such engines.

That looks like a small advance to make in three-quarters of a century, but it must be remembered that in the nature of things no large advance is possible. The best engines of 1835 had an efficiency of about 45 per cent. of that which

could be attained by an ideal engine; in the best engines of today this figure has been brought up to about 70 per cent. Working along present lines, we have made about all the gain that can be made. Not until 16 ounces cease to make a pound or until there are 101 cents in a dollar can more work be obtained from heat than that amount which corresponds with its drop in temperature.

Yet, the progress of the last two decades has not been negligible. There has been progress in overall efficiency rather than in engine economy, and this promises decided betterment in fuel consumption per delivered horsepower. Ideas as to plant arrangement have completely changed. Take the single matter of piping. Engineers have been closely studying power-station piping for about thirteen years. In 1898, we were using extra-heavy cast-iron fittings, screwed-flange joints, duplicate systems, ring mains, etc. The flared-over flange was brand new; cast steel was unheard of: the first special casting I ever saw used in pipe work was a gun-iron header installed in the Concord, Mass., electric-lighting plant in '99. We were just beginning to use pipe bends; there were only three (or, usually, two) places in the country where we could get them. All that has changed. The steamfitter of that day would be a cat in a strange garret if turned loose along the valve gallery of the modern station.

Thirteen years ago we were talking about magnetic clutches to connect engines and generators and the direct-driven unit was a novelty. The economizer was a matter of much interest but scarcely of immediate concern to the average man. Mechanical draft was a dangerously new invention. There were no stokers. We had just begun to talk about coal per kilowatt-hour and we did not have anything very creditable to ourselves to say. Today, we are rapidly improving some hitherto neglected details. We have been forced into the manufacture of better condensing apparatus and we are by no means through with that matter yet. We are faced with the question of superheat. We know that it pays—it increases gross earnings, so to speak—but we do not in all cases clearly know what it means finally in the year's business. Too much superheat has been installed with improper piping, valves, fittings and regulating devices. We are learning the mechanical requirements now.

It is a curious fact that the general type of apparatus adopted for some of the largest power plants has been determined by the insignificant (?) factor, cylinder oil. There is no way of thoroughly removing oil from exhaust steam under vacuum. If turbines are used, the exhaust steam is free from oil and many plants are using turbines partly on that account. If the older type of engine is used, with surface condensers, it is usually considered conservative engineering to throw away the condensed steam (although in a few plants they are filtering out the oil). Since in New York the circulating water is necessarily salt water, we must waste almost every unit of heat leaving the main-engine cylinders. With jet condensers we obtain the same result. Fresh city water might be used for condenser supply in connection with cooling towers; but it is problematical whether the very slight resulting heat economy would represent any commercial gain, and the cooling tower itself is scarcely to be regarded as standardized.

And in any case, we are face to face with the question of type of prime mover. The turbine has already shown a better everyday economy than its predecessor, although it has probably not quite equaled the latter's best record. This is from the technical, heat-unit standpoint. Commercially, the turbine plant costs less and will eventually cost very much less, so that it often has a distinct advantage. Along with this, the gas engine is looming up large, promising an efficiency well along toward double that of the best steam engines, but it is thus far handicapped by greater cost, lack of overload capacity, relatively poor efficiency at light loads and unproved reliability. Which of the three, reciprocating engine, turbine or gas engine, is to survive no one can yet say; final types have not been developed and final data are lacking as to thermal and commercial efficiency; but we may hazard the following surmises:

For direct connection to generators and other revolving machines where condensing water is available, the turbine should displace the reciprocating engine. Should its cost per pound be reduced to anything like that of the older motor, and if it can be made fairly efficient when running noncondensing, it may displace the latter in *all* applications where direct connection is possible. As to the gas engine: assuming the present rapid rate of development to continue, this form of prime mover should replace the steam plant in nearly all cases where, steam coal is high in price; the load factor is reasonably good, and there is no steam required for heating purposes. The gas engine will make more rapid progress as its underload efficiency and overload capacity are increased and its first cost is reduced.

The operating engineer's work is not confined to the engine room. Those who have to do with mill plants well know that large savings are to be made in the economical utilization of exhaust steam for heating and process work. This field is not being exploited as it should be. There are dollars to be found in the vacuum pan or steam kettle as well as in the cylinder and it is usual experience that they are somewhat easier to find in those places. You may have heard of the use of receiver steam from compound engines for process supply where steam at atmospheric pressure would not answer. You may *not* have heard of the proposal to run an engine at 20 pounds back pressure in order to supply a triple-effect evaporator. I see no objection and a certain gain. In the great majority of cases, ordinary exhaust steam is all that is necessary. Many a mill owner is superstitious about it; he thinks that exhaust steam is not hot, does not realize that with good circulation exhaust steam will warm his kettles up to 200 degrees just as quickly and reliably as live steam will. When a somewhat higher temperature is necessary, it may be better to pass the exhaust steam through a small separately fired superheater than to supplement it with a final live-steam boiling through special coils.

These are side issues, if important, to the main work of the engineer which is now more than ever centralized in the boiler room. As always, he must first of all keep things running. In the vast majority of plants this is the all-important consideration compared with which everything else is secondary. He must comply with local laws and ordinances and as far as possible avoid becoming a contributor to the smoke nuisance. A sufficiently difficult task this, with all the fuels of various grades, and it cannot be said that we have yet developed any generally applicable system of smoke prevention. Smokeless combustion is itself a matter of management, based on the coal, the equipment, the men and the load, and there is no infallible prescription for securing it. We can say, generally, that soft coal needs more air than hard coal; that the air and fuel must be thoroughly mixed to produce ignition, and that the flames must not be chilled until after combustion has been completed, that is to say, that about 10 or 12 feet of distance should be traveled by the products of combustion from the grate before they strike the boiler. These simple principles underlie the design of every "smokeless" furnace, dutch oven and soft-coal stoker in existence. We have recently developed another form of power-plant nuisance no less objectionable than smoke, namely, the discharge of fine cinders from plants burning low-grade buckwheat coal at high drafts and rates of combustion. In New York City there have been several criminal proceedings against plant operators who have offended in this way.

When we have mastered these things, in a reasonable degree, we have before us the whole field of plant economy. Here, if anywhere, a campaign of education will pay. It costs perhaps one cent in wages to shovel ten cents' worth of coal onto the grates, and I am afraid that we get good measure, that is, the willing fireman often makes it ten cents' worth of coal when it might be seven

cents' worth. We should remember that in no place are brains more needed than in the *expenditures* of life, and we ought to pay enough for fire-room labor to obtain the proper degree of intelligence. The firing of coal should be made more a matter of brain than of brawn.

How is this to be brought about? One of the popular magazines which has been publishing a great deal about scientific factory management suggests that we adopt a sort of piece-work basis, paying the fireman so much per ton of coal fired. I should rather work it the other way, paying him so much for every ton he did not fire. Everyone nowadays is interested in the new "efficiency" systems of wages. These systems are claimed to have nothing in common with piece work, but they resemble piece work at least in that the more a man does the more he earns. There is no reason why such systems cannot be introduced in the fire room, but, of course, what a man "does" there is not the amount of coal he shovels but the amount of steam he gets for each pound of coal.

It is a fortunate engineer who has a poor plant—particularly in a process mill. He has the best opportunity to make great records in economy, if he can only stand the strain of keeping the plant running. Of course, there is always an element of luck that cannot be depended upon; but in the long run, as Napoleon said, the luck is on the side of the best general. Power-plant management must be judged by its results like everything else from advertising to church going. Nobody is interested in our failures and mistakes. To save is our only excuse for existing. The plant which stands still in the matter of costs is the plant that is ready to start on the down grade of efficiency. It is a fight all the time.

A word as to records. It is a fine thing for an engineer to keep statements of fuel consumption, etc., from day to day, or even, if possible, from hour to hour. Generally speaking, the more records the better. One record that should certainly always be kept is a log, recording dates of scaling and washing boilers, packing rods and the like. Data on these points are necessary and easily forgotten. I am afraid that sometimes engineers' records become literature rather than bookkeeping, interesting rather than important. This happens when a man forgets that his daily coal weights, for example, should check with the invoices and inventory month by month. If they do not, they are not worth much; if the invoice weights are wrong, the office is concerned; if the boiler-room weights are wrong, they must be made right.

If we have any cure-all, any universal medicine, in the power plant and in business generally, these days, it is system. I hope that we do not carry it further than is profitable, but we cannot get along without it.

I sometimes think that it would be a good thing if every engineer were temporarily moved to a new plant for about four months once every two or three years. A new man will always see some new things in a plant—some disregarded opportunities for economy. The change would be good for each plant and it would teach the man some things, and when he went back to his own boiler room he would approach it with a more or less fresh view. I once looked into a mill which had a small closed feed-water heater supplied with exhaust steam from the auxiliaries. It was so overloaded that, although there was an ample supply of steam, the water could not be made hotter than 180 degrees Fahrenheit. When a condensing engine was installed later on, a large heater was placed between the engine and the condenser, and the feed water after passing through the old small auxiliary heater was put through the new large heater. It seems incredible that among all the people concerned there was no one who knew that steam at any vacuum, however poor, is colder than 180 degrees; at any rate, that was the arrangement when I saw it, and we had to buy two thermometers in order to prove to the superintendent that this heater was literally a feed-water *cooler*.

It is unfortunate that in engineering, as in everything else, we are all more or less apt to adopt fads. There was a time when everyone who preached power economy used boiler scale as a text, and we thought that we knew with mathematical accuracy just how much loss would follow the presence of so many sixteenths of an inch of scale. Our methods of treating scale were cure-all methods, and the idea of "making the punishment fit the crime"—of choosing a treatment adapted to the water and type of boiler—was scarcely heard of. I suppose that a critic might say that today the chief fad is air supply and CO_2. Perhaps this subject has become a fad in some places; we "know" a great many things about it that are not so; the facts of the matter are outnumbered by the fancies. Yet, disregarding all questions of measurement methods, recording apparatus and exactness of deductions therefrom, the incontestable facts remain that in the average plant an excess of air is admitted to the furnace; that this, by diluting the products of combustion causes the most serious preventable loss in the whole plant; that improvement in this direction is to be accomplished, not by the installation of expensive new equipment, but by intelligent control of the ashpit door and the damper. Between the plant where the air supply is right and that where it is badly wrong the difference may amount to half of the total fuel burned. Hard coal needs high draft, but not a great amount of air. Until we learn that air *pressure* is one thing and air *quantity* another we shall not get very far. We shall be about as intelligent as the engineer I once met in the West who knew no such thing as a pound of steam other than the "pound" registered on the steam gage. Men who have plants close to New York and are not interested in oil fuel, process steam or water power—here is a subject which concerns you and demands the best that is in you.

One of the chief needs in power-plant economy today is a better method for the purchase of fuel. When we buy anything else, we intend and aim to get what we pay for. Too many of us, in buying coal, take what we get. Every man who contracts to sell something is supposed to state what and how much he sells. It is very difficult to get sellers of coal to do this. Nobody seems to know less about coal than those who have it to sell. And we who have to buy it take it as it comes—more or less; there are some exceptions—although it is the largest single item of power cost.

Coal should be sold on the basis of its heat value and analysis and a pound paid for should weigh 16 ounces. Perhaps we need a National "pure-coal law" to protect us in this respect.

The value of coal to the user depends on its quality and whenever a contract is made it is based on the supposed quality of some sample or standard. If the quality descends, the coal is not worth the contract price and should not be paid for at such price. No matter whether the decrease in quality is ascertained by actual experience with the coal in the fire room or by analysis, the fuel should be condemned. It is cheaper and quicker to determine heat value and composition in the laboratory than in the furnace; the results are more accurate and less affected by variable conditions (a 500-horsepower boiler is a poor piece of experimental apparatus) and the only failures of analysis to give the same results as practice have been due to insufficient or improper analysis or an unintelligent interpretation of the results of analysis. This is one of those cases where troubles arise, not from "too much theory" but from too *little* theory.

We should not be called on to accept coal high in sulphur. We should not be handicapped with excessive percentages of moisture and ash; three dollars a ton is too much to pay for those things. If the volatile matter in the coal runs up to 30 per cent. and black smoke is produced, the coal man should be arrested, not the engineer. We are entitled to what we pay for. By previous experience or in some way, we pay for coal of defined properties. If we do not get such coal, within a reasonable limit of variation, we are not getting what we pay for. The coal dealer may say he has no control over these things, but *somebody* has, and we must reach that somebody through the man who gets our money. Take the mat-

ter of sizes, I have met men who did not know that No. 1 buckwheat meant a certain range of size. If we buy No. 1 and pay for No. 1, why do we not see that we get No. 1?

And then, there is the commercial problem of delivery. Those of us who operated plants in New York in the winter of 1903-04 know what happened to costs per kilowatt-hour during that time. Why? Because nearly every dealer defaulted on his contracts. We would not tolerate such a thing on the part of anyone else; why should we tolerate it when perpetrated by the coal men?

To city engineers with office-building plants, the prospect of coal shortage is serious enough, but to the mill engineer out in the suburbs it involves some additional troublesome problems. He must store coal at the beginning of the winter if he wishes to keep running in spite of strikes or railroad delays. Storage of coal is one of the most serious items of cost. We say nothing about the money tied up in the coal pile; the expense of handling and rehandling is alone rather staggering in a plant of any size. And then, there is shrinkage, in quality as well as in quantity. The hazard of fire is extremely serious, at least with soft coal, and fires in a coal pile are hard to put out.

These are some of the commercial aspects of a few of the problems entrusted to the operating engineer. This Institute of Operating Engineers is going to help us solve them. I believe the institute will succeed because it recognizes in its foundation two broad principles which accompany all great work and which are always associated with success: the principle of education and the principle of helping the other man—especially the younger man. We all need education, all we can get of it, and we need it before anything else. Our troubles come from too little, not from too much education. Therefore, it was wisdom to make education one of the institute's first aims. Just what kind of education operating engineers need and what shall be the program of getting it, will be gradually determined as time goes on. Let us merely aim high and then let matters shape themselves. It was most wisely said by the editor of POWER that the worth of your certificate of membership will be determined by the first one hundred holders of it. Be sure of your first hundred and you will be bound to grow in the right direction.

We sometimes forget what the word *engineer* means. In its derivation, it has no reference to engines. The engineer means the man who is ingenious, inventive, of wide-awake and active mind and who can meet and master situations with science and skill. If we remember that derivation, we will all agree that the word describes the highest and best type of engineer, the type we ourselves aim to be. Our work does not begin with the throttle and end with the flywheel; it does not even begin with the coal pile and end with a salary check; it is a part of the great work of efficient men all over the world making two blades of grass grow where one grew before.

Flywheel Explosion at Greensburg Ind.

Failure of the governor to shut down the engine after the breaking of the governor belt, was responsible for the wrecking of a flywheel at the works of the Bromwell Brush and Wire Company, Greensburg, Ind., at 7:30 a.m. on March 2.

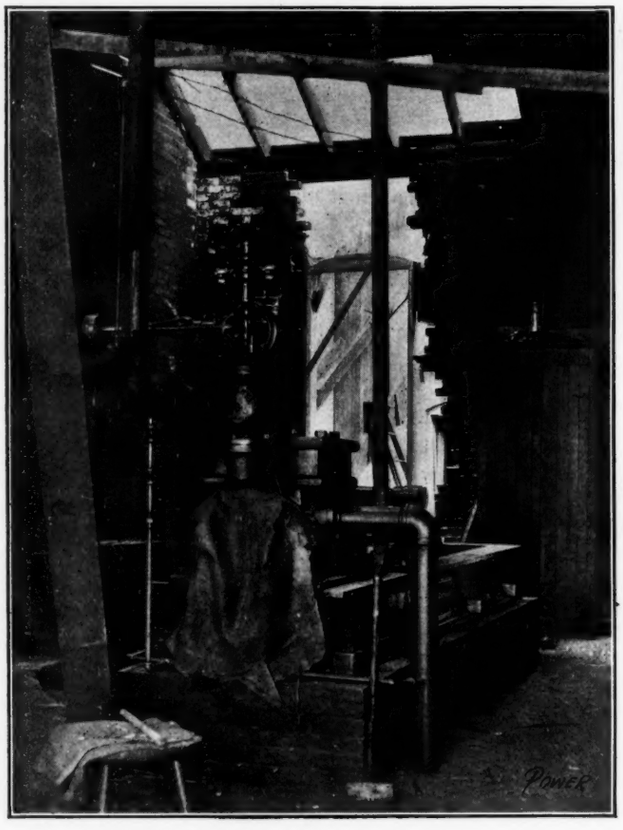


FIG. 1. ENGINE ROOM AFTER THE ACCIDENT

FIG. 2. PART OF RIM OF THE BROKEN FLYWHEEL MID RURAL SURROUNDINGS

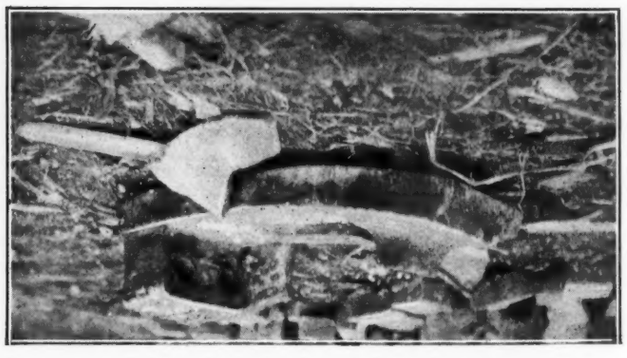


FIG. 3. ANOTHER PIECE OF THE RIM

The engine was of the old slide-valve throttling type, with a 14x24-inch cylinder and a 10-foot cast-iron flywheel made in two pieces. The rim was 10 inches wide and 2½ inches thick and was held together at the circumference by lugs, each containing two 1⅞-inch steel bolts. The normal speed of the engine was 110 revolutions per minute.

The engineer had left the engine room a few minutes before the accident to get a piece of 2-inch pipe from the storeroom. On his way back he noticed that the machinery was speeding up and hastening to the engine-room door he found the engine running at a dangerous rate of speed. As the throttle valve was directly in line with the flywheel and wide

open, he saw that it would be impossible to screw the valve to its seat before an explosion would occur, so turned and ran from the room. He had gone but a few feet when the wheel let go, a number of pieces tearing through the roof and side of the building, as shown in the accompanying photographs, wrenching the main shaft from its journals and breaking the frame of the engine. Pieces of the flywheel weighing from one to two hundred pounds were scattered all over the neighborhood, one of them landing in a corn field several hundred feet away, another crashing up through the floor of the main building and coming to rest in the attic.

FIG. 4. PART OF BANDWHEEL WITH PIECES OF FLYWHEEL IN BACKGROUND

No one was injured, owing principally to the fact that when the speed of the machines in the factory began to increase, all the operatives left their stations and made for the exits furthest removed from the power plant.

The flyball governor was equipped with a safety device designed to shut down the engine in such an emergency. This consisted of a ball-weighted lever, held up by the tension of the belt, causing the belt-wheel shaft, which was pivoted to swing loosely, to bear against a lug on the weighted lever, the idea being that should the belt break, the tension would be removed and the weight would close the valve and shut off steam.

After the accident this weighted lever was found in its upper position, and consequently the throttle valve was held wide open.

Engineer Bungle Repairs an Engine

"Blank the blankety blank double blank, blank luck. Blank * * ! * * * * ! * * * !"

The above is but a faint imitation of the sounds that came out through the open windows of a small country engine room. Waiting until I concluded it was safe, I ventured in where the commotion had occurred.

There I found a small slide-valve engine and a big, fat engineer with about as much expression as a half decayed potato.

The engine had been stopped and the reason was apparent from the broken valve-stem guide lying on the floor. The blacksmith's helper in trying to juggle a sledge hammer while passing through the engine room had accidently hit the guide with the hammer and broken it. The profanity had come from the proprietor of the sawmill, but he had departed to telegraph for a new part.

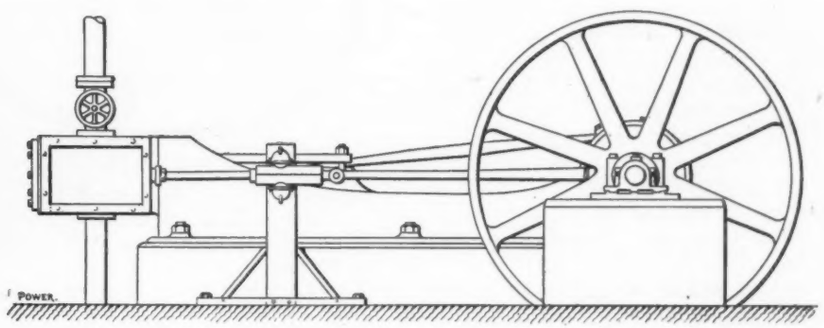
"In trouble?" I asked of the engineer.

"Yup," he replied, which was half a grunt.

"Why don't you surprise the boss and fix the engine so it will run?" I asked.

"Dunno how," was the answer.

After some more talk, I decided that the engine could be fixed up temporarily and run until the new part arrived. A stand was made of wood, the upright piece being braced as shown in the illustration. To the upright piece two window-cord pulleys were secured by hook bolts and nuts, after placing the frame back of the valve-stem guide in such a position that the two pulleys, when secured in place, formed a guide for the valve-stem end. The grooved pulleys served to prevent side play of the rod and were sufficiently strong to resist the thrust of the eccentric rod. The illustration shows the makeshift guide.



HOW THE ENGINE WAS REPAIRED

When all was ready, the engineer started up with fear and trembling, but soon had the engine up to speed.

Just then there was a shout and a clatter of horses' hoofs and wagon wheels, as the boss, on his return, seeing exhaust steam issuing from the exhaust pipe, hurried to find out what it all meant.

Not wishing to have any possible trouble with the proprietor, I stepped into the boiler room and, as I made my way past the engine-room windows, I heard him exclaim:

"Well, I'll be ——, Bungle, I didn't know you had half enough brains to do a job like that."

"Huh, is that so? Well, you ain't the only cuss as what knows a steam engin' from a cobble stone."

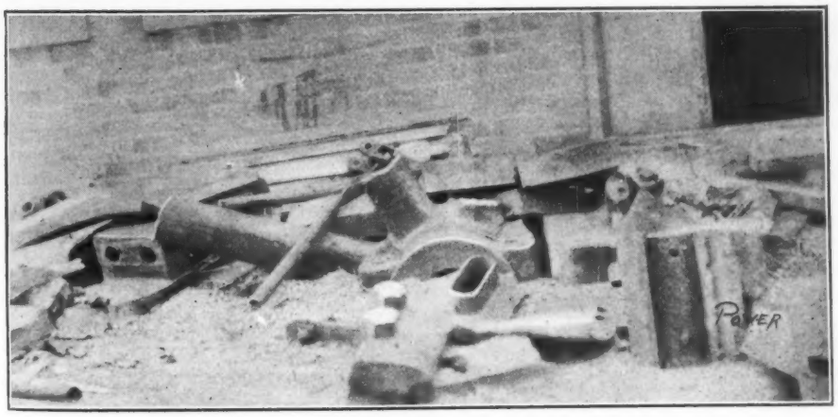


FIG. 5. PARTS OF FLYWHEEL AND MAIN JOURNAL

The lignite coals of Texas are excellent fuel for stationary plants and domestic purposes. The coal-mining industry in Texas at present is not extensive, but the time is not far distant when the State will rank as an important coal producer. There are thousands of acres of lignite coal in several counties of Texas. The coal runs from 4 to 10 feet in thickness, ranging from 30 to 90 feet under the surface. At different places in the same section coal is found at a depth of 125 feet. The seams have no gas or firedamp, and the lignite is easily mined.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Hydroelectric Developments in Georgia

By R. C. Turner

On February 8, the 24,000-horsepower plant of the Central Georgia Power Company, located on the Ocmulgee river at Jackson, Ga., was put into commission. The first line connecting out will be the line for Macon, supplying current for operating the street-car system and electric lighting. At present only 6000 horsepower is being used, but as soon as the connections are completed to several large manufacturing concerns near the city the load on this line will be increased to 16,000 horsepower. The lines into Macon will operate at 50,000 volts and are about 25 miles long. The lines leading to Atlanta, 75 miles long, will be operated at 100,000 volts. Branch lines from this feeder will extend to Griffin, Forsyth and Monticello. The current is generated at 6000 volts and stepped up for transmission.

The plant at Jackson is the first of the three which will be developed by the company; when the other two are completed the three will be capable of delivering 100,000 horsepower. The water rights for the other two plants have been secured and will be developed as speedily as possible.

The Georgia Power Company, which controls the rights for 200,000 horsepower in the State, is rushing the work on the development at Tallulah Falls, which will be largest single development south of Niagara Falls. The water from the head level will be conducted through flumes to the power house a mile away, and will have 600 feet fall. It is estimated by the engineers in charge of the development that this plant alone will be able to deliver 100,000 horsepower. Two three-phase lines will be operated at 100,000 volts pressure and will terminate at Atlanta, 90 miles south of the falls.

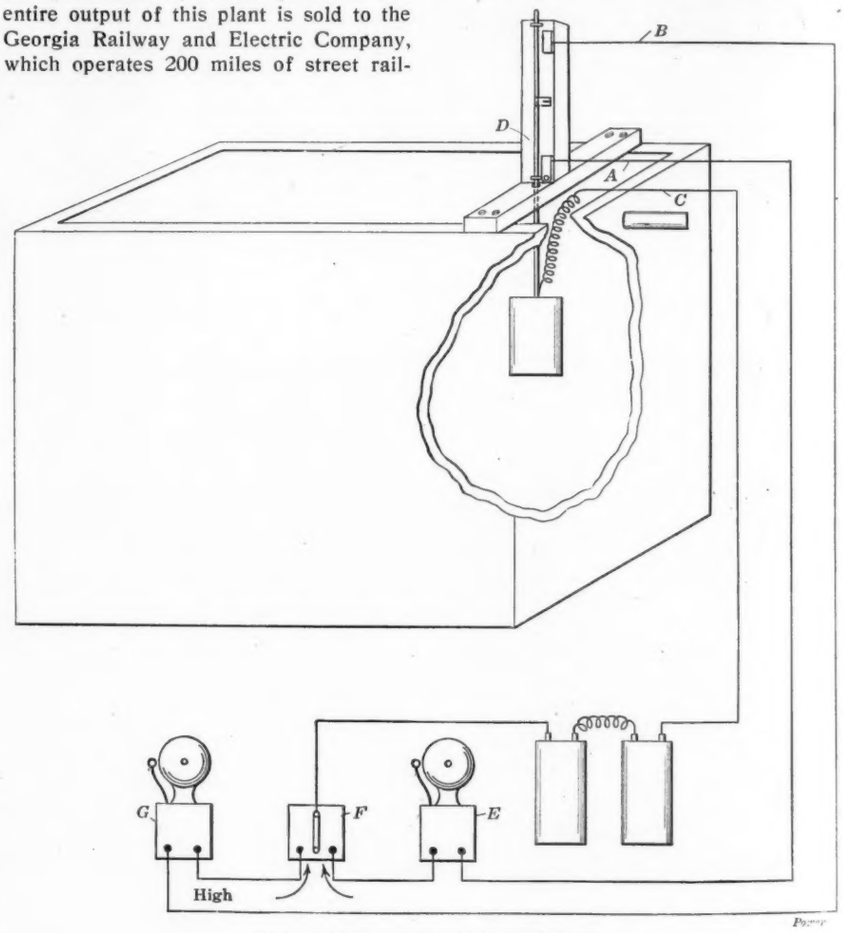
The 15,000-horsepower development of this company at Gainesville, on the Chattahoochee river, known as the Dean plant, has been completed and is supplying current to Gainesville, Buford and Norcross. A 50,000-volt line also is operated from this plant to Atlanta, 55 miles south of Gainesville. At the city limits the current is stepped down to 11,000 volts and delivered at this pressure to manufacturing establishments on the edges of the city. At Morgan's falls, 18 miles north of Atlanta, the company has in operation another plant, which has a capacity of 17,000 horsepower. Two three-phase lines terminating at Atlanta are operated at 22,000 volts pressure. The entire output of this plant is sold to the Georgia Railway and Electric Company, which operates 200 miles of street railway and a 20-mile interurban line to Marietta and also supplies current for electric lighting in Atlanta.

All the plants of the Georgia Power Company will be tied together so that a breakdown at one plant will not cause a dead shutdown. The properties of the company when fully developed will represent an expenditure of ten millions of dollars and will supply to Atlanta and vicinity 200,000 horsepower of electrical energy.

Water Tank Signal System

Most tank-signal alarms are equipped with an electric bell that rings until a switch is thrown, the signal being only for high water; but, in some instances, it is just as important to have a low-water alarm.

An alarm system for both high and low water in a tank is shown in the accompanying illustration. Two bells, a switch and two primary cells are used. The tank is square and has a cross piece reaching from one side to the other. This piece supports a wooden upright acting as a guide to the float rod, which slides through eye screws turned into the riser. A contact spring is attached to the float rod and comes in contact with the terminal blocks of the wires *A* and *B*. A third wire



Alarm System for Water Tank

C is connected to the float rod at one end and to the batteries at the other end.

The operation is as follows: When the water is low the contact spring *D* engages with the terminal *A*. This closes the circuit through the bell *E* and the battery when the lever of the switch *F* is thrown to the right contact head.

When the water is high the contact spring *D* engages with the terminal block *B*, closes the circuit through the bell *G* and the battery when the switch *F* is thrown to the left-hand contact head.

This arrangement permits the contact spring *D* to be engaged with either *A* or *B* for any length of time, as the switch *F* can be thrown on the central contact head. This arrangement is desirable in cases where the water level remains practically stationary for several days at a time, the switch allowing the engineer to test for the hight of the water at intervals.

Brush Setting for Interpole Motors

By R. W. Wilbraham

It is a well known fact that the good performance of an interpole motor is dependent upon exactness of brush setting far more than the common shunt-wound or compound-wound motor. Some trouble lately encountered with a number of small interpole motors brings this out remarkably well. The motors were all of the same type, rated at 1 horsepower, and designed for variable speed; they were compound-wound machines direct connected to the headstocks of wood-turning lathes. The speed range was from 800 to 2800 revolutions per minute, the first part of the range being controlled by armature resistance and the latter part by field resistance.

The motors were started up by a starting box which left them running at 800 revolutions per minute. As they were speeded up, some of them upon reaching 1600 revolutions per minute would stop and reverse, running at approximately the same speed in the other direction; others would do the same thing when passing from 2600 to 2800 revolutions per minute. It was then found that the motors that reversed at the 1600 point would not reverse until they reached 2600 revolutions per minute if they were speeded up very slowly. These particular motors, it was discovered, had no oil in the bearings. Upon being oiled, they could be rapidly speeded up to the 2600 point where, like all the rest, they would reverse. After making a number of tests, the conclusion was reached that the brush position was wrong. This proved to be the case and after setting the brushes backward (opposite to rotation) about one bar the trouble was entirely remedied.

The internal magnetic actions that take place are very interesting and are as follows:

In any motor when the brushes are ahead of the neutral point, as they were at first on the motors just mentioned, the armature reactions are less than normal and, consequently, the resultant magnetic field is stronger than usual. The result is that at each successive point in the speed range the armature falls more and more below the designed speed. As the counter e.m.f. of an armature is directly proportional to the speed, there is a proportional decrease in counter e.m.f. and a proportional increase in armature current, which results in a very strong armature field, the strength of which is relatively greater than the proportional increase of armature current.

In the case described, the higher speeds being obtained by field control, at the last point the field due to the field-magnet winding was very weak and the armature field very strong. The consequence was that the magnet poles were first demagnetized and then magnetized with opposite polarity, causing the motor to reverse. This reversing, as would be expected, was accompanied by sparking at the brushes due to the interpole polarity being wrong for the reversed rotation.

CORRESPONDENCE

Mr. Blue's Induction Motor Trouble

I have had the same experience with induction motors that Mr. Blue described in the issue of February 14, and I believe that his trouble can be cured by removing all the rotor conductors, thoroughly cleaning the ends of the bars and the short-circuiting rings and reassembling the structure carefully with a view to making the joints as nearly perfect as possible. The ends of the bars should be bolted to the short-circuiting rings for mechanical security and then thoroughly soldered to them to get good electrical joints. It might be well also to reinsulate the rotor bars with heavy manila paper wherever the original insulation has become worn. This will improve the torque.

J. E. Danforth.

Harrison, N. J.

In response to Mr. Blue's request in the issue of February 14 for suggestions regarding a "cranky" induction motor, I offer the following:

The facts that the motor starts in one direction on the second controller point and in the other direction only on full-line voltage indicate clearly that the trouble is in the starter. Wrong connections or, more likely, imperfect contacts should be looked for. On the day that the motor started all right but refused to take its load the starter probably failed to make contact on one phase in the running position. If it got current on both phases in the starting position it would have started and run near enough up to speed for one phase to keep it going when the lever was thrown into the running position. One phase being out and the airgap not uniform would account for its refusing to carry the load.

If the stator windings had been open-circuited it would have refused to start at all, and if they had been short-circuited the fuses would have blown.

In some instances the rotor bars become loosened from their connecting rings; in such a case the motor will refuse to carry full load. This may have been a contributing cause in this case but cannot have been the whole trouble as it does not account for the motor's behavior in starting; moreover, this trouble usually comes on gradually.

G. E. Miles.

Salida, Colo.

Melville-Macalpine Gear for Direct Current Generators

The letter of Mr. Malcolm, in the February 14 issue, pertaining to Mr. MacMurchie's discussion of large gear-coupled direct-current turbo-generator sets, is unfortunately not well founded. Mysteriously the salient fact has been overlooked that the use of the Melville gear permits the most efficient turbine and generator, respectively, to be employed, obviating the compromise necessary with the two different elements on a common shaft. The deductions in the second table are manifestly illogical. Turbine kinetic efficiencies were arbitrarily assumed by Mr. Malcolm. Had a value of 50 per cent. been taken also, for illustration, it could have been shown that the geared generator would have had to possess an efficiency exceeding 100 per cent. On the other hand, a higher turbine efficiency, say 70 per cent., which is feasible, would prove the direct-driven generator to be unreasonably low in efficiency.

I infer from the conclusion reached by Mr. Malcolm that he understands that the benefit resulting from the use of the gear would indicate an improvement chiefly in the generator, while, in fact, the greater gain in economy occurs in the turbine, and very much so on small sizes. From a mechanical standpoint, however, the geared generator has the advantage of more desirable commutation speeds.

On determining the Rankine-cycle efficiency, Mr. Malcolm applied an actual water rate for saturated steam against the ideal steam consumption for 100 degrees of superheat and identical pressure conditions. The efficiencies derived are, therefore, lower than they should be, accordingly affecting the values in this second table. Furthermore, the comparison with a turbo-alternator and rotary combination has, in the criticism, been deemed irrelevant, which is immediately

refuted by the fact that such combinations have been installed for the express purpose of obtaining direct current immediately at the point of generation, before the large gear had been completely developed and which system was given preference over the large direct-coupled continuous-current turbo-generating unit. To my knowledge four such plants have been installed.

In looking at the first cost of the geared set disparagingly, Mr. Malcolm loses sight of the facts that standard turbines and generators may be used while for direct coupling the designs must be special.

Mr. MacMurchie's presentation of the comparison, in my mind, is entirely equitable, and is in conformity with the actual performance of the different elements.

EDWIN D. DREYFUS.

East Pittsburg, Penn.

Mr. Dreyfus' comment on my article relating to Mr. MacMurchie's paper is in error in at least one point: I did not assume any turbine efficiency in preparing the table accompanying my article; I simply took Mr. MacMurchie's figures for steam economy and worked back from them to see what would be the probable distribution of the overall efficiency between the turbine and the generator on the basis of 97 per cent. efficiency for the gear.

My assumption of 100 degrees of superheat for the turbine was based on the fact that this is commonly assumed in discussing turbine plants. If Mr. Dreyfus prefers a comparison based on saturated steam at the turbine throttle he will find it in the accompanying tables. The theoretically available energy in a pound of steam expanded adiabatically from 150 pounds pressure to the condenser pressure corresponding to 28 inches of vacuum is 319½ heat units. According to Mr. MacMurchie's figures the direct-connected unit would require 20.6 pounds and the gear-driven unit 19.3 pounds of steam per kilowatt-hour, showing overall heat efficiencies of 51.85 and 55.34 per cent. respectively. If the Melville-Macalpine gear has 97 per cent. efficiency, the geared turbine and generator must have a combined efficiency of

$$\frac{55.34}{0.97} = 57.05$$

per cent., as compared with 51.85 per cent. for the direct-connected turbine and generator.

Not knowing what Mr. MacMurchie allowed for turbine and generator efficiencies separately under the two sets of conditions I have simply presented in Table 1 a list of possible turbine efficiencies and given opposite each the generator efficiencies necessary to fit the stated overall efficiencies; in Table 2, the generator efficiency is the starting point.

Mr. Dreyfus seems surprised that I should construe Mr. MacMurchie's paper to mean that the use of the gear would

TABLE 1.

Turbine Efficiency.	Corresponding Generator Efficiencies.	
	Direct Driven.	Gear Driven.*
54	96.02	.....
56	92.59	.....
58	89.40	98.37
60	86.42	95.09
62	.....	95.02
64	.....	89.15

permit the use of electric generators of higher efficiency. As Mr. MacMurchie's paper contained that specific statement I do not see how I could "construe" it otherwise. However, assuming that facility of commutation is the only generator advantage and that the turbine gets all of the increase in efficiency, Table 2 gives the direct comparison.

TABLE 2.

Generator Efficiency.	Corresponding Turbine Efficiencies.	
	Direct Drive.	Gear Drive.*
86	60.3	64.4
88	58.9	62.9
90	57.6	61.5
92	56.4	60.2
94	55.2	58.9
96	54.0	57.7

*Assuming 97 per cent. efficiency for the gear.

It is conceivable that a large turbine running at a favorable speed will show an increase of 3½ to 4 per cent. in efficiency, as indicated by the table, when compared with its performance at a lower speed. But it is also quite reasonable to suppose that the generator efficiency would suffer somewhat by a reduction in speed. I cannot imagine a turbine (other than the De Laval) of 1500 horsepower that would require such a high rate of speed for maximum efficiency as to carry the generator beyond its maximum-efficiency rate of speed.

However, that phase of the question is scarcely worth haggling over; it is within the reach of imagination that in relatively small units the use of the gear might effect some improvement in overall efficiency and an appreciable reduction in the cost of the turbine, but I believe the cost of the gear would more than eat up the gains.

The bald truth is that increased facility of commutation is the only real excuse for using anything except a direct coupling between a turbine and a direct-current generator. Whether or not that justifies the expense I am not sure; only a practical demonstration would convince me.

GEO. W. MALCOLM.

Brooklyn, N. Y.

Would It Have Been Serious?

Under the title "The Light That Failed," in POWER for January 31, Howard H. Bliss tells of a retiring operator who, through spite, filed a brass connection thin, with the idea that it would melt as a fuse when the synchronizing lamps were at full candlepower and thus extinguish them and cause the new operator to close the switch and throw two machines together when they were farthest out of phase.

I believe, however, that the probabilities of success for the scheme are very remote. In the first place it would have required very fine calculation to have enabled the man to file the brass so it would melt just when the lamps were at full candlepower. The chances are that it would either have melted too soon or not at all. In the second place it is not likely that anyone would have thrown the machines together the first time that the lamps went dark, and the fact that they stayed dark would or should have aroused suspicion and led to investigation. In the third place, had the brass melted just when the lamps were at full candlepower, they would have gone out suddenly and not gradually, as is the case when machines are near enough the same speed to be thrown together. This would or should have caused the operator to hesitate. He would have expected the lamps to light up again just as suddenly and would not have risked closing the switch. Their failing to light again would have started him looking for trouble.

I do not mean to say that it *could* not have happened as planned, but I hope that if ever anyone tries to make synchronizing trouble for me he will choose as uncertain a way as the one described; I believe that in the majority of cases, cold snap or no cold snap, that plan will result in nothing more serious than the trouble of running down an open circuit.

Salida, Colo. G. E. MILES.

John T. Nicholson, of high-speed boiler fame, in a letter to *The Engineer,* of London, upon the comparative merits of the cut-and-try method and mathematical investigation, says: "Mechanical engineering is not only an art or a craft, but it largely consists also in the application of mathematical and physical principles. Men who do not possess a good knowledge of these principles are incapable of foreseeing in what way a new apparatus will behave. They can in fact only repeat with slight and timid modifications what other engineers have done before, and as Professor Perry has said, 'By dint of expensive trial and failure they sometimes arrive at results which they might have arrived at very inexpensively if they had been better educated.'"

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Notes from the Gas Power Plant at Gary

Some of the engines in the mammoth power house of the Indiana Steel Company at Gary, Ind., have now been in operation over three years and it is interesting to note the experiences encountered. During the first few months there were slight difficulties, due mainly to the inexperience of the operators. One or two cylinders were cracked (but are still in operation) and some troubles from back firing and preignition occurred. It did not take long, however, for the operating engineers to become familiar with the engines and now everything is said to be running as smoothly as could be desired. The alternating-current generators have a nominal rating of 2000 kilowatts each at 80 per cent. power factor but regularly carry from 2500 to 2800 kilowatts. Units are cut in or out so as to maintain this high unit load as nearly constant as possible.

As the power is largely used in the rolling mills the load is subject to frequent variations and it may happen that an engine will be started and stopped a dozen times during the day. This is done with much facility now; it is not usually over one minute from the time an engine is ordered into service until it is on the line in parallel with the other machines. The shortest time in which this has been done is 37 seconds.

The engines operate on the waste gases from the blast furnaces and as there is available more power than is needed at the plant electricity is regularly supplied for lighting the city of Gary, for operating the water works and for private uses. In addition to this, some power is delivered to the plant of the Universal Portland Cement Company at Buffington, Ind.

The Gary power house operates in parallel with the power house of the Illinois Steel Company at South Chicago, where gas engines, steam engines and steam turbines are in operation. The junction point of the lines is at Buffington. This arrangement enables either plant to supply power to the other in case of necessity, or both can supply the cement plant.

The Boott mills, Lowell, Mass., are gradually going over to electric power, which is being bought from the Lowell Electric Light Company. The company, however, soon expects to furnish its own power.

LETTERS

Mr. Rushmore's Freak Diagrams

In the February 28 issue, Mr. Rushmore shows two "freak" indicator diagrams taken from a single-cylinder producer-gas engine. If the diagram illustrated as "first freak" had been properly taken, the work diagram outline would have extended farther to the left, as it did in the "second freak." It is impossible for an indicator to produce a card of that kind if the external connections, springs, etc., are in good working order, unless the direction of rotation of the flywheel is reversed, and it appears that this did not occur in Mr. Rushmore's test. I attribute the first freak to a faulty external connection, catching of the indicator cord, or sticking of the drum spring. I cannot understand why compression did not begin sooner, because by laying a tracing of Mr. Rushmore's normal diagram over the expansion curve of the first freak diagram I find they coincide almost exactly,

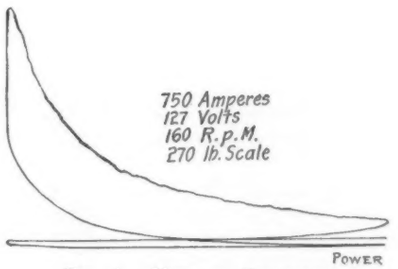


FIG. 1. NORMAL DIAGRAM

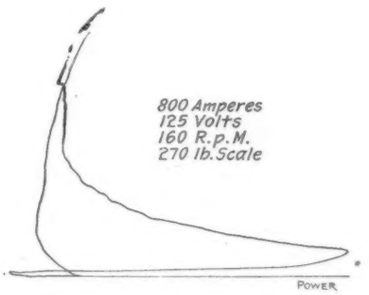


FIG. 2. FIRST FREAK

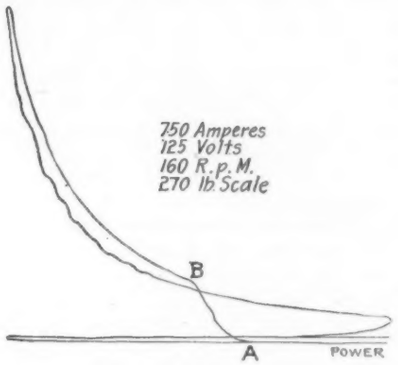


FIG. 3. SECOND FREAK

which means that practically the same quantity of gas and the same number of heat units were taken into the cylinder and ignited. Fig. 4 shows Mr. Rushmore's first and second diagrams superimposed; from this it can be seen how nearly the curves coincide, the dotted curve being taken from Fig. 1, his normal diagram.

I would call his second freak a case of preignition. Ignition occurred at the point *A*, which caused the rise in pressure to the point *B*, and the completion of the cycle is nothing but a case of compression of highly heated gas and its reëxpansion. Trying to determine the cause of preignition from the diagram alone would be mere speculation on the part of anyone not acquainted with the engine.

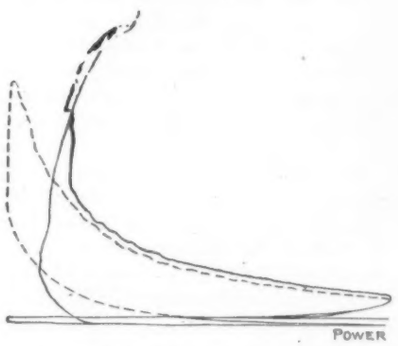


FIG. 4. FIGS. 1 AND 2 SUPERIMPOSED

W. F. SCHAPHORST.
Agricultural College, N. M.

There is no mystery about Mr. Rushmore's diagrams. Compare the length of

the diagram labeled "first freak" with that of the normal diagram. It is considerably shorter, indicating that a knot or joint in the indicator cord slipped near the head end of the stroke. The diagram is not complete; the compression line is not indicated until near the end of the compression stroke and at this point the indicator cock was thrown open.

The second freak was caused by preignition due to overload. The high peak is a sign of full or overload in using a throttling governor. Ignition took place slightly before the piston reached the middle of the compression stroke and the momentum of the flywheel carried the piston against the explosive pressure, as indicated by the rising compression line. The expansion line falls below the compression line because of the loss of heat through the cylinder walls.

HAROLD DOOLITTLE.

Birmingham, Ala.

The Diesel Engine and Engineers

I read in the February 21 issue the article by Edward B. Pollister on "The Diesel Engine in Service," and I share Mr. Pollister's good opinion of the Diesel engine.

About five years ago I took charge of a large power plant in central Europe containing a 1000-horsepower horizontal cross-compound steam engine and a four-cylinder Mirrlees-Diesel engine of 225 brake horsepower direct-coupled to a 150-kilowatt generator. The Diesel engine was five years old, but it carried its load successfully with great economy, running only at night for lighting service. During my two years of service the biggest repair was a new piston for the air compressor, but I spent about ten hours every two weeks in inspecting and taking up connections and various other parts, and had the men blow out all piping and wash out all other parts with kerosene. I did not take the pistons out every time, but turned the crank over and cleaned out deposits in the cylinders with sponges and kerosene, working through the suction and exhaust-valve ports. The engine ran satisfactorily and never scored the cylinders.

I presume that Mr. Pollister understands that the Diesel engine is successful only when operated by skilled engineers who have had proper training; an internal-combustion engine, whether using gasolene, gas or crude oil, will not run with the exhaust valves opening 4 inches late or with the eccentric set 5½ inches of the stroke late, as will some Corliss engines.

I do not say that there are not skilled men in plenty; there are well trained, capable men in the United States and Canada, but plant owners cannot expect to get a well educated and skilled engineer for $70 to $75 a month to work 66 and more hours a week and be ready to respond cheerfully whenever the night engineer calls him out of bed to clear up trouble in the water or steam line, or to fix up a balky ignition system or a cranky mixing valve. Under such conditions there need be no wonder that 90 per cent. of the capable men are working at manufacturing trades instead of running power plants.

In the hands of the right sort of engineers, the Diesel engine is the most economical prime mover known.

J. G. KOPPEL.

Montreal, Can.

Generator Linings

The method of lining a gas generator described by C. R. McGahey in the February 7 issue is interesting, but I think it would be unnecessarily expensive. We set the firebrick in 8 inches from the shell and fill in behind the lining with sand. As we have no trouble, we believe the method is all right. I think, also, that this is the way it is generally done in this part of the country.

J. O. BENEFIEL.

Anderson, Ind.

Mr. Barker's Engine Speed

In the issue of February 28, Mr. Barker asks if a speed of 300 revolutions per minute is practical for a vertical gas engine of 9½ inches bore and 12 inches stroke with a connecting rod 30 inches long.

In my opinion this speed is practical. I have one 11x12-inch gas engine running at 300 revolutions per minute with connecting rods 36 inches long; also, a 12x12-inch engine running at 275 revolutions per minute with connecting rods 36 inches long. Both engines are three-cylinder verticals with long trunk pistons lubricated by splash from the crank case, and both run 12 hours per day, under about the same conditions. The crank-pin and piston-pin brasses of the 12x12-inch engine need adjusting every two days but the brasses of the 11x12-inch engine need adjusting only about once a month. The pistons and cylinders show very little wear and have been in service over eighteen months.

M. W. UTZ.

Minster, O.

The piston speed of a 9½x12-inch engine at 300 revolutions per minute is not too high, but the flywheels should not be more than four feet in diameter because at 300 revolutions per minute the rim speed of a 4-foot flywheel would be 3600 feet per minute. The safe working speed being about a mile a minute, this would leave enough margin for safety in case the engine should run away.

It is very seldom that the flywheel of a gas engine breaks from excessive speed; more often the connecting rod breaks, due to the piston being heavy and being cushioned only at one end of the stroke every other revolution.

N. E. WOOLMAN.

Danbury, Iowa.

An Inconsistent Engine

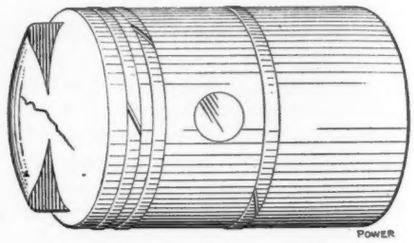
A small four-cylinder vertical gasolene engine which seems to be in first-class condition runs faster when the pet cock on cylinder No. 3 is open than when it is closed. Can anyone explain why?

FRED HALL.

Dexter, Mo.

Cracked Piston Faces

I have taken several pistons from gasolene engines that were cracked through the top, as shown in the sketch. I should like to have expressions of opinion from



PISTON WITH CRACK IN FACE

other readers as to what makes them crack in the top and the best method of repairing them. Can they be brazed or closed up with Smooth-on cement or patched with soft patches?

JNO. G. KOHNSBERG.

Hathaway, Tenn.

Petroleum in Turkey

According to Consul George Horton, the importation of Russian petroleum into the Saloniki district is increasing despite Hungarian competition, which is handicapped by higher freights. As nearly as can be ascertained the imports of petroleum into this district in 1909 were as follows, in cases: Russian, 370,000; Hungarian, 50,000. The figures for 1910 will show a decided increase.

American petroleum is imported in small quantities, but on account of the higher price the demand is not important, despite its acknowledged better qualities, viz., less odor and clearer light. Before the opening of the Batum wells petroleum was exclusively imported from the United States, and the market was lost through the inactivity of the American producers; but it can be regained, and steps to this end have been taken by the purchase by an American company of a site here for tanks and a factory. This real-estate transaction has caused considerable interest here as the company was forced to pay an exorbitant price for the land. A Hungarian company had already purchased a site, but it is now rumored that it is ready to sell it and retire from the contest.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Constant Receiver Pressure

Recently I visited a power station in which there were one 24 and 48 by 48-inch and one 26 and 50 by 60-inch cross-compound condensing engine. The large engine was running with a receiver pressure of 12 pounds; in a short time they shut down this engine and started the small one and carried a receiver pressure of but 6½ pounds.

I asked the engineer why he carried 12 pounds receiver pressure on one engine and but 6½ pounds on the other. He replied that the engine with the low receiver pressure had just been repaired and that it did not require any more, but that the engine carrying 12 pounds receiver pressure was old and required repairs, so he had to carry a higher receiver pressure to make it do its work.

The engineer said that the engines had not been indicated since he had been there, some nine years, and that he guessed the engine cylinders balanced.

I told him that he ought to indicate his engines, adjust the valves, equalize the cutoffs and then work out his cards to see which cylinder was doing the most work, and, if the low-pressure side was not doing the same amount as the high-presusre side was, to shorten the cutoff on the low-pressure side and raise the receiver pressure until both cylinders were doing the same amount of work.

I have also noted that the receiver pressure of many cross-compound engines varies as much as 20 pounds. With some engines the pressure goes up when the load goes off; with others it goes up when the load comes on. I contend that if an engine is properly constructed, valves properly set and the load balanced between the two cylinders, it should maintain the same receiver pressure at no load that it does at full load, providing that the governor controls the cutoff on the low-pressure cylinder as well as on the high-pressure cylinder. If the governor controls the high-pressure side only, this is not possible, as the low-pressure side has a fixed cutoff.

When a large engine is running with a variable load and the receiver pressure varies from low pressure at no load to a high pressure at full load, the high-pressure cylinder will do most of the work until the receiver pressure is built up. With a constant receiver pressure, the instant the load is thrown on, the low-pressure cylinder is ready to do its share of the work without waiting for the pressure to be built up in the receiver.

When the load is suddenly thrown off, steam to the high-pressure cylinder is cut off shorter, less steam is taken, and the low-pressure cylinder likewise cuts off steam shorter at the same instant, keeping a constant receiver pressure. The low-pressure cylinder is ready when the load is again suddenly thrown on to do its share of work at the same instant the high-pressure cylinder takes its load.

W. R. BEARD.

Cleveland, O.

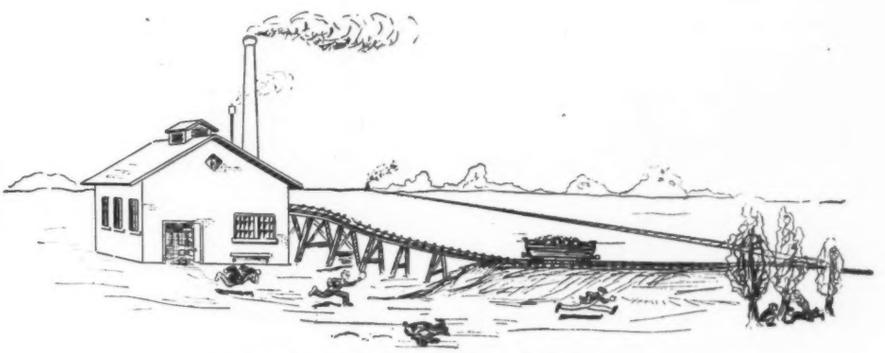
White Hot Boiler Stampeded the Firemen

In a steam plant containing 12 return-tubular boilers it is the custom for the day shift to wash out, clean, fill and prime six of the battery every Sunday; the night shift fires them up and has steam ready by six o'clock Monday morning.

Not long ago this same routine was gone through with as usual. The night shift fired up and everything went along smoothly until about 5 a.m.

These boilers are fed by mechanical stokers and each fireman feeds four stokers and attends to the feed water. The fireman on No. 3 boiler had an empty stoker and was about to refill it when he thought he would have a look at his fire. He opened the little door on the side of the stoker through which a slice bar is usually thrust and what he saw almost threw him into a fit; but he did not take time to indulge in one. With white face and standing hair he raced down the boiler room, shouting as he ran, "Biler g'er bust." The other firemen, coal and ash wheelers, seeing his white face and wild actions, surmised something was wrong, and without stopping for orders started after the leader until seven men were doing a "marathon" up the coal trestle and down the railroad track. About 1000 feet from the plant they came to a stop behind piles of railroad ties, trees and other objects and then beset the panic maker for an explanation.

What that fireman saw in that momentary glance into the peek hole was enough to "frazzle" the nerves of the most reckless shovel mechanic who ever held a scoop. The first fire sheet was hanging down to the grate bars and was white hot all over. While the fireman was informing his fellow workers of how the boiler looked, he ducked at every second word as if the expected crash was coming, and the rest would duck in unison with him.



THE FIREMEN DID NOT STOP TO ASK QUESTIONS

After about half an hour's breathless waiting for the boom that did not come, one of the firemen, braver than the rest, started back. He got to the boiler house and found the master mechanic on the job.

The boiler that had caused the scare had cooled off, for, as there was no more coal in the hopper the grate had gradually burned bare. The boiler was at once cut from the others and an investigation disclosed the trouble. There were two gages of water in the glass, but both gage cocks were closed. The re-

pairs consisted of a new sheet and a full set of tubes.

The firemen and coal and ash wheelers came back, but the fireman who caused the stampede did not even return for his hat and coat.

A. R. HILBERT.

East Rutherford, N. J.

What Is Wrong with the Valve?

The automatic cutoff engine, from which the diagrams shown in Fig. 1 were taken, was apparently running satisfac-

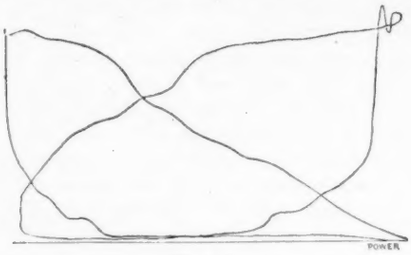


FIG. 1

torily at a speed of 215 revolutions per minute. The governor was keyed to the shaft and there was no way to shorten the valve rod except to heat it. After taking the diagram shown in Fig. 1, I

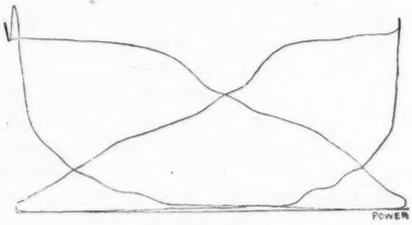


FIG. 2

shortened the rod ¼ inch and took those shown in Fig. 2.

Upon removing the valve-chest cover all that could be seen was a square piece of cast iron. I came to the conclusion

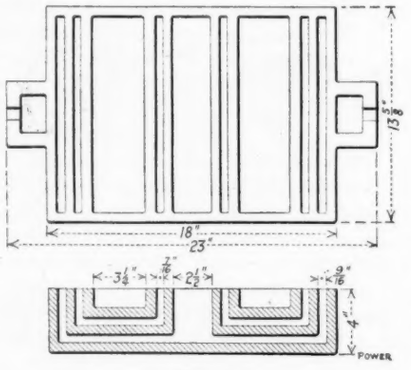


FIG. 3

that the man who invented the proposition never intended to run it. Fig. 3 shows the face of the valve. Who ever saw one like it?

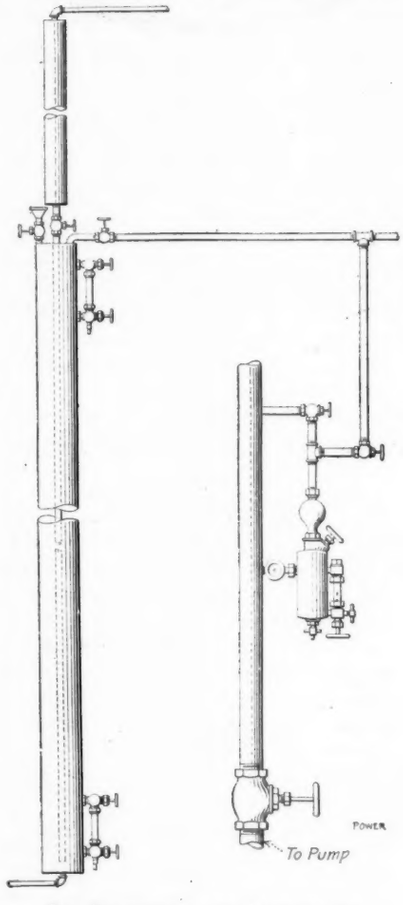
ALLEN J. STOCKS.

Seattle, Wash.

Lubricator Connections

Some time ago I took charge of a water, light and power plant in which there were ten sight-feed lubricators. The oilers always filled them to overflowing, which caused a waste of oil at each filling, amounting to about ½ pint per day. Then there were the time and waste necessary to use in cleaning up the lubricator and floor.

This loss and annoyance were overcome by using a piece of 4-inch gas pipe, 10 feet long and capped at each end to form an oil chamber. A ¼-inch hole was tapped in the lower cap for a drain pipe and a ½-inch hole drilled in the center of the upper cap. A ½-inch pipe, 9 feet



OIL RESERVOIR AND LUBRICATOR CONNECTIONS

10 inches long, was screwed inside of the 4-inch pipe, through the upper cap. A valve was put on the upper end of the ½-inch pipe just outside of the 4-inch cap. Then 3 feet of 2-inch pipe was placed above the ½-inch valve to serve as a condensing chamber and was connected at the top to a steam header.

I also connected a ½-inch pipe in the 4-inch cap and extended it to the individual lubricators. A gage glass was placed near the top and bottom of the oil chamber to indicate the hight of oil. The main feed line is attached to each individual lubricator just above the condenser bulb by means of a tee and valve as shown.

C. J. BEACH.

Iola, Kan.

A Makeshift Gin Pole

I was recently sent to erect a boiler and engine on a rice farm. Work went along smoothly until I was ready for the 40-foot gin pole, but none was to be found. Two 20-foot sections of 3-inch gas pipe were finally obtained and coupled together. A piece of wood was driven into one end of the pipe, to which a short crossarm was nailed to support the guy lines and hoisting ropes. As there was a derrick over a well the raising of the gin pole and stack was an easy matter.

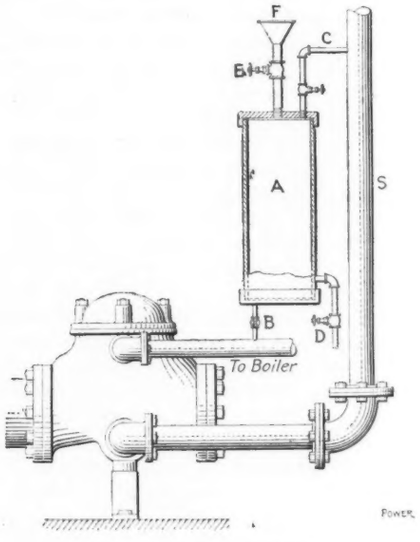
ERNEST BECK.

Marianna, Ark.

Compound Feeder

In the accompanying sketch is shown a convenient method of feeding boiler compound, where the pump receives water under pressure, as from an overhead tank.

A cylinder, which may be made from



COMPOUND FEEDER

a piece of 12-inch pipe, capped on each end, is shown at *A*. A ¼-inch pipe *B* and valve runs from the discharge of the pump to the bottom of the cylinder. *C* is a ¼-inch pipe leading from the top of the cylinder to the suction pipe *S*.

A ½-inch drain pipe *D* leads from a point near the bottom of the cylinder. *E* is a 1½-inch pipe and gate valve through which the cylinder is supplied with boiler compound.

To refill the cylinder with compound, close the valves *B* and *C* and open the valves *D* and *E*. The cylinder will drain through the valve *D*, which is then closed

and the cylinder fills through the valve *E*, which is then closed and the valves *B* and *C* opened, when the apparatus is at work.

This is a particularly good arrangement for feeding soda ash as there is no possible chance for the pipe to become clogged and the force of the entering water is a great aid in dissolving the soda ash.

J. D. CHAMBERS.

Tacoma, Wash.

Engine Needed Indicating

The accompanying diagrams are from a 16x42-inch Corliss engine running at 100 revolutions per minute. The diagrams

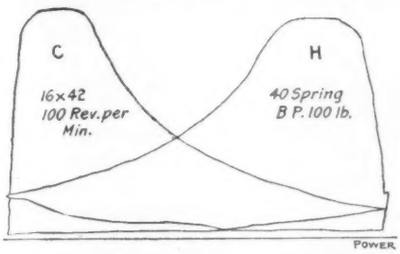


FIG. 1. BEFORE SETTING THE VALVES

shown in Fig. 1 were taken from the engine as I found it, and those in Fig. 2 as I left it.

I would like to have some of the indicator men figure the saving made. They

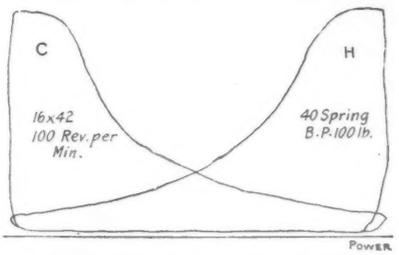


FIG. 2. AFTER SETTING THE VALVES

had two boilers in operation before the change and could run with one afterward. It required but 20 minutes to make the adjustments.

H. T. FRYANT.

Memphis, Tenn.

Pressure on Pump Plunger

If, in a single-acting triplex power pump, with the cranks set at an angle of 120 degrees, and the space below each plunger be connected with a suitable pipe, and, if this space is filled with water, can the crank shaft be turned around one complete revolution without the pressure on the water being raised, and indicated by a gage attached to the pipe? Or, in other words, will there be a constant volume during all parts of the revolution?

This problem came to me while trying to locate the cause of a breakdown on a triplex pump, which was of the piston type, but was single acting, and discharging only when the plungers were descending. The top ends of the plunger cylinders were all connected beneath the stuffing boxes, with a suitable sized port. This port was supposed to connect with the suction also, but had become stopped up.

Now the question is, if the plungers did not leak, would there be excessive pressure on top of the plunger when the pump was in operation?

B. U. POTTER.

Holyoke, Mass.

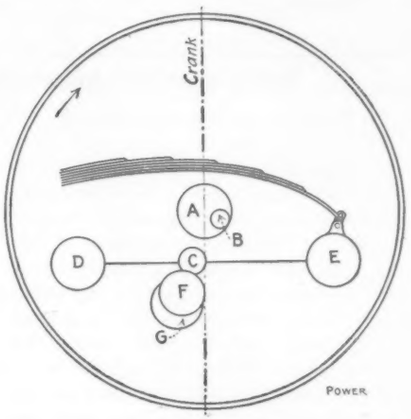
A Governor Problem

Recently a governor problem came up, a discussion of which may be of interest. It is as follows:

A diagrammatic sketch of an inertia shaft governor is shown herewith, in which *A* is the engine shaft, *B* the eccentric, *C* the point of suspension of the weight arm, *D* one of the two weights attached to one end of a weight arm, the weight having a pocket so that shot may be added. *E* is the other weight, which is made up of removable plates, and *F* is the weight connected to the weight arm. The hollow part of the weight *D* was filled with shot, all of the plates were removed from the weight *E*, and 20 pounds of lead were added to the weight *F*, as shown at *G*. Why were these changes made, and what effect did they have on the speed of the engine?

After carefully analyzing the sketch it seems to me that the aim in making the change was to change the center of gravity of the weight arm so as to increase the centrifugal force and at the same time keep the inertia effect practically the same. By removing the plates from *E* and adding shot to the weight *D*, the center of gravity of the weight arm is shifted toward the weight *D*. Since the weight *E* is made lighter and the weight *D* is made heavier there is less tendency for these weights to balance each other and, consequently, the inertia effect of the weight arm is decreased and the centrifugal force is increased because the weight *D* is increased and its distance from the center *C* remains the same. Since the weight *E* was lightened the inertia effect of the weight arm was decreased and in order to make up for this inertia 20 pounds of lead were added to the weight *F*, as shown at *G*. Now the weight *E* has practically no effect on the centrifugal force of the governor because the center of the shaft, the center of the pivot *C* of the weight arm and the center of gravity of the weight *F* are very nearly in a straight line. The effect of the weights *F* and *G* is almost entirely that due to inertia; therefore, by adding the weight *G* to the weight *F* the inertia of the governor was maintained and, consequently, the sensitiveness of the governor was not lost, but by increasing the centrifugal force by shifting the center of gravity of the weight arm the power of the governor was increased.

The centrifugal force of the governor being increased, the speed of the engine



SHOWING WEIGHTS ON GOVERNOR ARM

will be decreased because the governor will respond at a lower speed.

T. W. HOLLOWAY.

Scranton, Penn.

Operating a Dangerous Boiler

An old boiler, located in the oilfield of Ohio, is used to steam and pump oil about two hours in four weeks. It remains idle the rest of the time, but a small flame from a gas jet keeps the water from freezing.

One morning the boiler was fired up to steam a tank of oil preparatory to pumping it into the line. When the steam gage registered 100 pounds pressure the front head sprung a leak around the handhole plate, which promised to drain the boiler in short order.

The fireman started the injector, but seeing that the water was dropping about an inch a minute he drew the fire and, after the boiler had cooled down, an examination showed that the front head was so wasted away around the handhole that two holes were visible and the head could be punctured with a light tap with a hammer. The rivet heads of the rivets joining the head to the sheet had entirely wasted away. The front head was originally ½ inch thick, but up to the third row of tubes showed a thickness of ¼ inch.

This boiler is of the firebox type and of about 25 horsepower. It does not come under the license law of the State, and is fitted with an old ball and lever valve set to operate at 100 pounds pressure. It is 15 years old and has been almost continually exposed to the weather. That the boiler did not explode is a mystery, but it will have another chance, for it was patched up again and put in service at 100 pounds pressure and is doing business at the old stand.

M. W. UTZ.

Minster, O.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Indicator Cord Hook

A hook for connecting the cord from a reducing wheel to the rod on an engine crosshead was described in the February 7 issue. I have used this form of hook and, although it serves the purpose admirably, have found that the one shown in Fig. 1 is more convenient to connect. The distance between points *A* and *B* is a trifle larger than the diameter of the rod on the crosshead. The hook is held at the head end of the engine stroke and tilted as shown so that the rod will pass between *A* and *B*, whereupon it will readily connect.

This hook cannot be used satisfactorily with high-speed engines when the reducing motion is obtained by link work. For this purpose I have used the connector shown in Fig. 2, which is made of moderately stiff wire, a little longer than the stroke of the pin prepared for cord attachment, that is, about 3 or 4 inches. To use this connector, the indicator drum is drawn to the end of its stroke by pulling on the cord *C*. The wire is then slipped over the end of the reciprocating pin so as to take the position shown in Fig. 2—the dotted circles representing the end-stroke positions of the pin. Now, by allowing the indicator-drum spring to draw the wire to the right

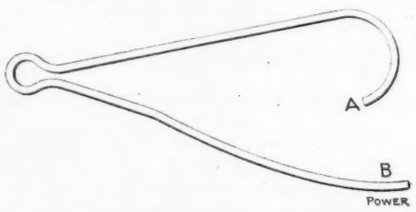


FIG. 1. CONVENIENT CONNECTOR FOR ENGINES OF MODERATE SPEEDS

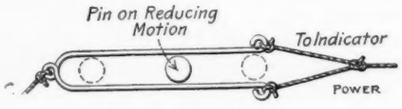


FIG. 2. CONNECTOR FOR HIGH-SPEED ENGINES

until the pin strikes it at the end of its stroke to the left, the "hooking up" is very easily accomplished. The end of the cord *C* should then be attached to some convenient point so that it will not swing around the link motion. When disengaging the indicator, this cord *C* is used, the wire connector being pulled with it until free of the pin.

If it is found at all difficult to slip the wire in place on account of its ends being drawn together, the form shown in Fig. 3 may be used. In this case the wire is bent so that its legs have a slight spring outward which is taken up as soon as the indicator cord becomes

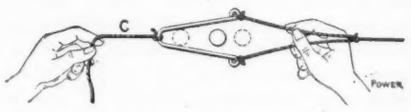


FIG. 3. ANOTHER FORM OF CONNECTOR FOR HIGH-SPEED ENGINES

taut. The right hand is used only to slip the wire over the pin; after this is done, the hooking up is as before.

JULIAN C. SMALLWOOD.

Syracuse, N. Y.

See Your Plant as Others See It

Referring to the first-page editorial in the March 7 issue, it is a good plan for a chief engineer to get away from his plant occasionally and do some visiting around among the other plants. It tends to broaden him and gives him a better knowledge of engineering matters in general. It also enables him to get many valuable ideas which he can apply in his own plant to his own and his firm's advantage. Ideas gained in this way make a lasting impression and cannot be obtained in any other manner.

Most engineers are confined so much to their own plants that they are more than likely to get into a rut and overlook many things about it which might easily be changed in a way to give better economy. As long as they do not have an opportunity to see how the engineers of other similar plants are handling them and overcoming their troubles, they are likely to continue in the same old rut to the detriment of both themselves and their employers.

When an engineer visits other plants he frequently notices things which he knows could be changed in a way to produce better results and when he returns to his own plant he is likely to find that he has the same set of conditions or a worse set. The reason why he had not noticed it before was that he had became so accustomed to it that it escaped his attention until he had traveled around visiting the other plants and got jarred out of his rut.

I believe that the best investment that a firm can make is to give its chief engineer a couple of weeks off each year with full pay and expenses and have him spend the time visiting other plants in order that he may keep uptodate.

If the engineers who are unable to get away from their plants would make it a point to ask questions of all of the traveling men who call on them, they would probably be surprised by the amount of information that they can gain in this way. A great many of the traveling men today are well posted on engineering practice, many of them having had years of practical experience in the engine room and, as they are constantly visiting plants of various kinds, they are always able to give an engineer much valuable information. In addition to getting all of the information possible by discussions with others an engineer should read as many journals and books on the subject as possible.

S. KIRLIN.

New York City.

Slipping Latch Blocks

In the February 28 issue, I read C. L. Greer's reference to slipping latch blocks of Corliss engines. Of course, the steel plates should not be allowed to become so worn that slipping off is liable to occur. It is to prevent this that daily inspection of the plates is a regular rule in some power plants, particularly in large power and lighting stations. Whenever the edges begin to get "rounded," as they call it, the plate is to be turned so that a new and square edge is presented for wear. Sometimes, though, an engineer thinks that a certain plate will last through just one more run and he allows it to remain. After running for, perhaps, three-quarters of the watch, slipping begins, much to the annoyance and disgust of those concerned. It is not desirable to shut down to effect a repair, especially as the watch is almost up, and so various things are tried to keep the engine going until it is cut out of service at the proper time.

It is better to prevent the possibility of such slipping off, but if caught during a run, try the following: Squirt kerosene oil on the plates, and the slipping will stop, or the slips will not be so frequent. Turpentine is better still and seems to have the same effect as roughening the surfaces with a smooth file. Still another expedient that I have tried is to wipe off all the oil or grease and chalk the edges of the contact plates.

CHARLES J. MASON.

Scranton, Penn.

The Pabst Verdict

In regard to the damage suit growing out of the recent boiler explosion at the Pabst brewery, I am unable to agree with the opinion of B. J. Morrison, as reported in the February 21 issue, that the initial rupture came in the main steam line and that, as a result, the water in the boiler flashed into steam, causing an overpressure and the resultant explosion. I should expect a sudden escape of steam to produce a reduction of pressure in the boiler.

Professor Breckenridge's belief that the reinforcing plates prevented the drums from conforming to a true circle seems far fetched, as his belief must be equally applicable to the reinforcing strip at the butt joint.

The lack of information regarding the general layout of the plant and the position of the points of supposed initial rupture in relation to surrounding objects precludes any reasonable judgment being formed regarding the primary cause of the disaster. The appearance and location of the several parts subsequent to the explosion tell very little of value in founding just judgment regarding the cause or source.

JOHN W. PAYLER.

Detroit, Mich.

I have just read the report in the February 21 issue of the verdict in the Pabst boiler-explosion damage suit. I was at the scene of the explosion on the morning after it occurred and examined the wrecked boilers as best I could.

If the boiler tubes had been connected into the sides of the drums instead of into the bottoms, the disaster might not have occurred. The expansion and contraction of the straight tubes caused the excessive "breathing" action and the weakening of the plates.

The theory that the steam line let go first has no substantiation in my opinion. An accident occurred to a tug-boat boiler here recently and I had a chance to observe the effects. A bridge swung around and broke off the main stop valve. The boiler did not explode, although it was rather badly distorted, and the staybolts were pulled away from the sheets.

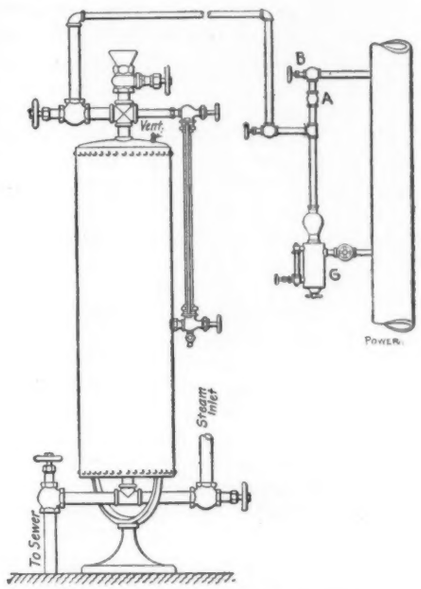
JOHN DOE.

Milwaukee, Wis.

Oil Reservoir Layout

In response to Mr. Pierce in the February 21 issue, I submit the following on a "central-station" lubricating system which I installed in a hotel: A 30-gallon tank was procured and set up as shown in the accompanying figure. The figure is self-explanatory.

Some engineers might prefer a simple sight feed instead of a complete lubricator at *G*, but I prefer using the lubricator as then the outfit is "hooked up" double. If for any reason the "central station" is out of commission, the lubricator can be filled in the old way from "Grannie's" teapot and used as originally intended until such time as the system is in commission again. I would advise anyone who installs a system of this kind not to forget the vertical check *A*, as I have found by actual experience that valve *B* can be opened mysteriously.



ARRANGEMENT OF OIL RESERVOIR

CHARLES P. WEAVER.

Buffalo, N. Y.

Size of Air Chamber

In the issue of February 21, F. A. Dew wants to know about the air chamber on a power pump. I think all of the trouble is in the suction pipe and the knock or pound of which he speaks is a water ram or hammer in the suction pipe. If he will tap the top of the suction pipe for a ¼-inch pipe and use either a valve or a pet cock to admit a little air, the pound will stop. The cock should be closed when shutting down the pump so as to prevent the water from going back to the well. I have tried this scheme and know that it will work.

C. S. TALLMAN.

Cripple Creek, Colo.

I have read of Mr. Dew's trouble in the February 21 issue and I would like to offer a few suggestions.

In the first place, is there a foot valve on the lower end of the suction line?

When a volume of water in a suction pipe or a pump is once set in motion it is quite important, especially when dealing with high speeds, to stop it gradually. For this purpose a vacuum chamber is often placed on the suction side of the pump. Perhaps a vacuum chamber would eliminate some of Mr. Dew's trouble.

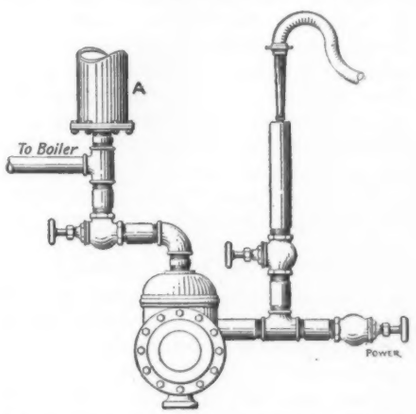
WILLIAM A. VEDDER.

Fort Logan, Colo.

In the issue of February 21, F. A. Dew requests information regarding air chambers.

As a rule for diameters I have taken three times the diameter of the discharge pipe for the diameter of the air chamber and sixteen times the diameter for the length.

Water hammering of check valves is easily overcome, if the operator will study the conditions that cause the hammering. The size of the air chamber used to overcome the hammering depends upon the amount of air that the water absorbs and the means at hand to refill the chamber with air. The proper point at which to install the air chamber is at some elbow near the pump, preferably on a tee in a vertical pipe in direct line with the flow of water as shown at *A* in the accompanying figure. With this arrangement the air chamber takes the direct blow of the water from the pump and then transmits it gradually to the line. The aim is to keep the water flowing as uniformly as possbile.



POSITION OF AIR CHAMBER AND METHOD OF REPLENISHING IT

With no pressure on the line the chamber would be full of air; with 15 pounds pressure the chamber would be one-half full of water; at 45 pounds it would be three-fourths full and at 105 pounds the air would occupy only one-eighth of the space that it did at atmospheric pressure. At high pressures the water absorbs the air very rapidly.

To refill the air chamber with air, close

the suction valve and open a valve between this valve and the pump and place a hose in the short section of pipe, as shown in the figure. As nearly all pumps have two suction connections, one on either side, the one not in use can be used. By the means just described air will collect in the air chamber because the water, being heavier, will force the air to the top. The air chamber can thus be refilled whenever the check valves give the slightest indication of hammering.

C. A. DAVIES.

Cincinnati, O.

Advice on Giving Advice

In answer to E. L. Morris' appeal for aid in solving his radiator trouble there were several suggestions printed in the February 21 issue, each of which is adjudged by its author to remedy the difficulty and warm the cold radiator. What surprises me is to see that no two correspondents come to the same conclusion. If I were in Mr. Morris' position I believe I would be in as much of a quandary to decide which bit of advice to follow as to solve the heating problem itself.

This multiplicity of advice (often conflicting) I believe to be one reason why so few interesting problems of this kind are sent in for the consideration of the practical readers of POWER; and it has been the reason, in past instances which can be pointed out, why some smart (?) writers have sent in perplexing and often ridiculous conundrums, the correct answers to which were immaterial to them, and beneficial to neither art, craft nor science. I do not wish it to be understood that the editors should restrict the number of published answers to the two or three which may agree—for, often, replies bearing little on the subject under consideration contain some instructive matter applicable to other cases—but that the editors should review the replies sent in, and at the end of a discussion issue their own advice or give some one correspondent's answer such a conspicuous position in the paper as to denote that they favor it.

If Mr. Morris should write directly to the POWER editors, I do not doubt that he would receive a satisfactory solution or, at least, some kindly suggestion that would aid him to reach a conclusion which would lead to the elimination of the trouble. Now, why cannot POWER make public such answers? Do the editors suppose that their own opinions would be uninteresting to the readers or do they fear criticism of their answers? Possibly they refrain because they were not asked for their own advice. Surely that is a poor extenuation, but it is more charitable to surmise this than that they forbear because of the humor derived from the diversity of opinions which are sent in.

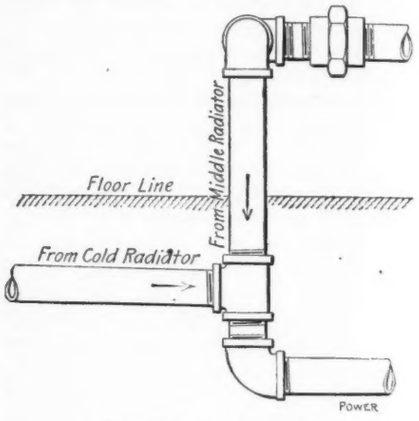
It may be considered somewhat imperious of me in giving advice as to the lines along which answers should be given to such an inquiry as the one under consideration, but it may benefit some writers who are willing to state their opinions, to learn how their advice could be made more valuable. Also, the inquirer may benefit by my endeavor to show how to glean and adopt what is valuable in the replies given. I do not proffer an opinion of my own but merely point out the facts already given by my fellow correspondents.

It is essential that the adviser place himself in the position of the inquirer and remember that the trouble must be eliminated at as little expense and with as little inconvenience to the tenants as possible; therefore, it is unreasonable to expect expensive changes to be made unless it is certain that such changes will improve matters materially. It is, then, the recipient's first duty to discover whether any of the remedies suggested are applicable to his case. Applying this principle to the case under consideration, one may infer from Mr. Noble's communication that the trouble is due to the water of condensation in the supply pipe. To test the correctness of this assumption Mr. Morris should "break" the union between the valve and the radiator and let out all of the water until steam issues freely. If now the coil heats up after reclamping the union, he would at least have found the cause but the remedy suggested—supplying an extra line of piping—may be inconvenient.

If the water of condensation flows out slowly when the union is apart, a lack of pressure may be inferred and Mr. Dixon's theory that all of the steam condenses before reaching the radiator is correct. The remedy would be either to lessen the percentage of friction by supplying larger sizes of piping, as he suggests, or to carry a higher boiler pressure. It would be well, however, first to make sure that there is no obstruction in the pipe itself. This can be ascertained by closing the valves on the other two radiators and maintaining a good head of steam on the line.

Mr. Plowman's suggestion that air-vent valves be placed on the outlet end of the radiators is good advice, but this is so well understood by the veriest novices that it is here taken for granted that Mr. Morris' radiators are equipped with them.

From Mr. McCoffin's letter it might be inferred that the water of condensation chokes the riser tee when steam emanates horizontally from two outlets. If this is the case, closing the valve of the right-hand radiator should cause the left-hand radiator to heat up. If this fails, Mr. Morris could try Mr. McCoffin's idea on the return tee of the middle radiator as shown in the accompanying figure. The condensate from the middle radiator will now have a tendency to siphon the air in any pocket that might exist in the left-hand return pipe. In any case, the arrangement is an effectual check to the backing up of the water of condensation and should be beneficial if its advantages are not offset by a too great reduction of the general angle or dip of the return pipe. To test this suggestion Mr. Morris should close the valve on the middle



REARRANGEMENT OF TEE

radiator, when, the cause of the choking at the return tee having been eliminated, the entrained water should flow freely from the cold radiator.

These are but a few suggestions whereby Mr. Morris can aid himself to detect the trouble without tearing things apart. If it be possible, answers to inquiries should contain a statement of some method whereby the suggestions which they contain may be tested without undue expense.

OWEN R. OWEN.

Roxbury, Mass.

Low Pressure Turbines

I read with interest Mr. Fenno's letter published in the January 30 issue in which he took exception to the statements made in the catalog published by one of the turbine manufacturers. I also noted in the February 28 issue, Mr. DeGroot's attempt to disprove Mr. Fenno's analysis.

While all of the statements that Mr. DeGroot made are true and really do occur in practice, I believe that they have no application in the present instance, as the original assumptions were all made on theoretical grounds alone, that is, the comparison of the number of B.t.u. rendered available by a pound of steam expanding adiabatically from 150 pounds gage pressure to atmosphere, and the same pound expanding adiabatically from atmospheric pressure to a 28-inch vacuum, was made on theoretical grounds alone. If it was made on theoretical grounds, Mr. DeGroot's criticism is not warranted. If it was not made on theoretical grounds, the original figures, giving the amount of energy available in the two ranges of expansion, are not correct.

If a pound of steam expands adiabatically from 150 pounds gage to atmospheric pressure, it must of necessity have a quality at the end of expansion of about 86 per cent., as pointed out by Mr. Fenno. If it does not have this quality, the pamphlet referred to had no right to assume that 160 B.t.u. were rendered available for useful work. Furthermore, I do not believe that Mr. DeGroot has any right to introduce the subject of re-evaporation, because if this is present then the expansion is not adiabatic, which would be contrary to the original assumption.

I also believe that Mr. DeGroot errs in introducing the subject of a drop in pressure at release, which would evaporate the wetness fraction in the steam. The original assumption being that the reciprocating engine expanded the steam adiabatically down to atmosphere, and that the turbine started with steam at atmospheric pressure, of course precludes the supposition of any drop in pressure.

As mentioned above, I believe that all of Mr. DeGroot's statements are correct, but the original assumptions do not allow the application of his argument to the case in hand. I, therefore, believe that as we are arguing solely on theoretical grounds, Mr. Fenno's criticism is perfectly just and warranted.

SOL. SIEGEL.

New York City.

Organization

The first-page editorial in POWER for February 21 should cause engineers to "sit up and take notice." Comment is made on the fact that economic engineers, lubricating experts and specialists of other types are used by owners of steam plants more frequently than ever before. The opinion is given that the operating engineer, who is constantly about the plant, should, and generally does, know more about the plant than any expert that can be called in.

The writer of the editorial sees no reason why a chief operating engineer should not be able to install a new plant, if called upon to do so; and, further, advises all engineers to break away from routine once in a while and view the plant as an outsider through a binocular. Such articles in theory and on paper look fine and tend to raise the pride of the "knights of the throttle," but an essential thing to determine is why the operating engineer is usually consulted at the last moment.

In the first place, the engineer in a one-man plant is usually regarded as a necessary evil. The mill cannot run without him and as his energy has disappeared in the products of the other employees there is nothing visible that he leaves behind him after the day's work that can be sold for a profit. Such being the case, the object is to get as much work out of him as possible and give him as little in return both in money and credit as he will consent to accept. The chief of a one-man plant has to use more ingenuity on and do more scheming over a two-cent job than does the average business man over the problems with which he meets in the business world.

The owner of the one-man plant demands first-class results from all the old junk that has been collected in the course of time. When these results do not materialize the engineer is immediately dubbed no good. He is asked to buy and use second-hand pumps, belting, pulleys, hangers, shafting, engines and boilers; in fact, he runs up against the second-hand proposition so often that when he begins to think of dying he more than half expects to go to a second-hand hereafter. If the second-hand goods do not look as well and give as good results as first-class new goods, the engineer is unceremoniously told that he has done a poor job and the "main guy" audibly wonders why he cannot have things looking as well and giving as good service as in some places where only first-class machinery is purchased, and he comes to the sage conclusion that it is because his engineer is no good.

There is not much doubt that the average engineer could install a new plant and is perfectly able to replace an old one without the aid of a specialist, expert or consulting engineer. But he is seldom given the same latitude that the so called expert is given. For instance, the engineer says to the boss, "We must have a separator on the steam line."

"Nonsense," is the reply, "we have gotten along for years without one and they cost money."

The boss listens to all of the engineer's arguments, gives bored attention to his data and does no more about the matter until an "expert" comes along and gives one-half the reason already advanced by the engineer, and the boss "falls" for the separator.

The engineer in a plant of under 150 horsepower capacity has no routine, his work is all over the shop. He is the engineer, fireman, machinist, electrician, wireman, dynamo repairer and tender, carpenter, plumber, steam- and gasfitter, beltmaker, etc.; he must be able, ready and willing to jump in and repair any machine that may go on a strike. If he cannot or will not do any or all of these things, he is either no good or lazy or both. Now, why are things thus? There is one very good reason: the average engineer does too much and, because he does so much, he loses the respect of his employer who comes to look at him as a little higher grade man-of-all-work than the general run of "lumper."

The carpenter, machinist and other skilled laborers in a factory do what they are hired to do and no more; and they are not asked to do more. Why? Because they have an organization back of them that defines their hours of labor, kind of labor and the wages they shall receive and the employer, if he can help it, does not care to clash with the trades union, recognizing that it is an unprofitable argument. But as the engineer has no organization back of him, the employer gives it to him for all that he will stand.

All the engineers realize their need for more and better knowledge. But, in my opinion, there is something else they need to acquire as well, and that is, "organization" knowledge. "To earn more, learn more," is a mighty fine motto, but when we find mechanics who master their trade in three or four years getting a shorter day and higher wage than the engineers, who may not hope to ever master theirs, we know that they have learned something that the engineers have not. They have learned that collective bargaining for hours and wages "knocks the spots" out of individual bargaining and, having learned, they have put their knowledge to use.

It seems to me that the engineer should take a night course in some good school that teaches organization and when he has learned a little, get together with his fellows. If he applies his knowledge of organization one-quarter as well as he has his knowledge of mechanics, he will put his trade in the lead of all trades.

G. G. HALL.

Dorchester, Mass.

A Practical Compression Test

I have read with some interest the article by Charles J. Mason under the above caption in the February 28 issue. I cannot see wherein it was a "compression test" at all. He says that the engines had "considerable compression" in both high- and low-pressure cylinders, and were operated under a boiler pressure of 150 pounds and a receiver pressure of 15 pounds. Now, instead of changing both compression and receiver pressures, why did not the engineer change only the compression? Then there would have been a test. But I should think that any engineer would know that 15 pounds receiver pressure with full-load conditions, the usual ratios for cylinder volumes and a boiler pressure of 150 pounds, was not a proper amount. Had the engineer simply increased the receiver pressure and left the compression just as it was, he would have made a great improvement in the efficiency of the engines.

It is unfortunate that diagrams were not shown in connection with the report of this test. The term "considerable compression" is rather vague. If the compression was excessive in both cylinders,

then there was an unnatural condition, under which any amateur ought to be able to effect an improvement. This matter of compression is one on which engineers are in better agreement than they really know themselves to be. I do not know of any engineer worth mentioning by that name who defends compression as a *brake on the engine.*

Mr. Mason states that positively, the changes having been made—that is, the receiver pressure raised and the compression reduced—the engines used less steam with the same load. This may be readily conceded without even admitting that it was the result of reducing compression, although I am willing to concede that it probably helped. But how could we expect that a heavily loaded engine, with properly proportioned steam cylinders, high- and low-pressure, 150 pounds boiler pressure and only 15 pounds receiver pressure, would give satisfactory performance? How could we expect compound results from so nearly simple conditions? I think that the vast majority of engineers will agree that the increase in receiver pressure from 15 to 25 pounds caused most of the improvement.

It is quite clear that if the cylinders were properly proportioned, the high-pressure cylinders were doing most of the work during the moderate- to heavy-load periods. Naturally, one would not expect economical operation under such conditions.

To claim that this test demonstrates that the compression was or was not economical is hardly warranted. Had the receiver pressure been left as it was, that is, at 15 pounds, and the changes of valve setting made, and the test made under this condition, then we would have had something that could really be called a compression test.

WILLIAM WESTERFIELD.

Concordia, Kan.

Sizes of Turbine Steam and Exhaust Pipes

With reference to W. J. A. London's charts for selecting the size of steam-turbine steam and exhaust pipes, which appeared in POWER for February 21, I agree that the curves are convenient and will save much calculation; but they are not, I consider, based on correct principles. I will confine my remarks to the size of exhaust pipes.

Mr. London has fixed on a constant velocity for all vacua down to 24 inches. This is not, I think, scientific, neither will it work well in practice. The lower the pressure of the exhaust steam, the greater is the velocity which can be employed with a given loss of head; and, moreover, the cost of reducing the velocity by increasing the section of the pipe is, with low exhaust pressures, and consequently large volumes, much greater than with higher pressures. It therefore follows that with high vacua a greater velocity should be allowed than with low vacua, other conditions being the same. Mr. London has, to a certain extent, acknowledged this by allowing a velocity of only 100 feet per second for steam exhausting at atmospheric pressure, while for vacua above 24 inches he allows 400 feet per second.

Another point should, in my opinion, be considered. The friction in a small pipe is greater than in a large pipe for the same fluid at the same pressure and the same velocity. The curves should, therefore, I believe, be based on the allowing of higher velocities with large pipes than with small ones.

I would be pleased to have Mr. London consider and criticize the following formula for the area of exhaust pipes and ducts:

$$A = \frac{W^{0.8} V^{0.5} f^{0.4}}{C}$$

where

A = Area of exhaust-steam pipe or duct in square feet;

W = Pounds of steam per hour passing through the pipe or duct;

V = Volume in cubic feet of one pound of this steam;

f = Periphery in feet of a figure of the shape of the cross-section of the exhaust pipe or duct and of an area of one square foot, and

C is a constant which for condensers for land turbines may be taken at 16,000. Where weight is of greater import or back pressure of less consequence, C may be given a higher value.

The formula was given in my paper on "The Design of Surface Condensers," which was read before the Institution of Engineers and Shipbuilders in Scotland in February of last year. It will be seen that it applies whatever be the section of the exhaust ducts. The ducts sometimes have a rectangular section. It does not matter whether W represents the weight of steam only or the combined weight of steam and water of condensation, so long as the corresponding value is taken for V.

R. M. NEILSON.

Glasgow, Scotland.

Homemade Tube Cleaner

In the February 14 issue, E. H. Marzolf describes his homemade tube cleaner. He does not state what size of tubes he can clean with it. If he uses it for 3- or 4-inch tubes, 16 to 18 feet long, he will learn that the greater portion of the soot will accumulate near the back end of the tubes. The perforated cap at the end does scatter the steam in a number of currents and impedes the velocity, which should be as great as possible. Volume and high velocity of steam are essential to a good tube cleaner and I fail to see why he uses the perforated cap.

J. W. DICKSON.

Memphis, Tenn.

Emergency Pipe Repairs

I was much interested in Mr. Taylor's description of two kinds of pipe clamp in the February 14 issue.

On two occasions I stopped a leak in a pipe where it was not convenient to apply a clamp.

Fig. 1 illustrates the arrangement used in the first case. The leak was in a 2-inch feed-water pipe. Some 1¼-inch fittings and nipples were put together as shown. A 2x2-inch piece of No. 10 gage iron and some packing were placed over the leak. Then, a 1-inch nipple was placed between the valve disk and the sheet iron and the disk screwed down

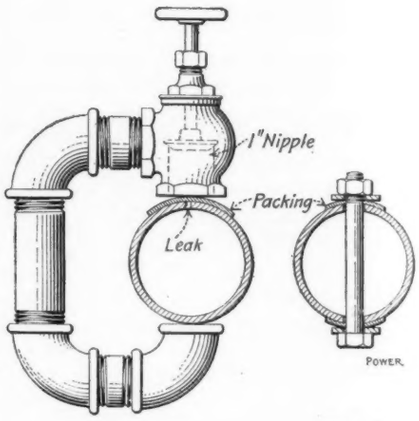


FIG. 1 FIG. 2

TWO METHODS OF STOPPING A LEAK TEMPORARILY

hard. The job lasted until a more workmanlike repair could be made.

In the second case, a leaking 2-inch feed pipe was repaired as shown in Fig. 2. I bored a hole clear through the pipe and inserted a bolt with washers and packing under the head and nut as shown. This makeshift did the trick until the pipe could be replaced.

HARRY E. MCARTHUR.

Port Blakeley, Wash.

An engineer who is envious of his neighbor's lot, because the latter has a more uptodate plant, is assuming an attitude which will hinder him in reaching the top of the ladder. As a matter of fact, in opportunity to gain experience and show his worth, he possesses a distinct advantage over his neighbor. Good equipment and ideal operating conditions never contributed toward the making of a good engineer; it is the experience gained in making the best of a poor equipment and devising means to overcome operating troubles that increases an engineer's worth.

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POWER

Will an Isolated Plant Pay?

What with depreciation and amortization and obsolescence and apportionment of charges and all the other intricacies with which the modern exponent of power-plant economics cumbers up the process, the plain business man may be excused for not knowing how much his output costs per horsepower-hour or per kilowatt-year. The central-station solicitor, whose salary or commission depends upon landing contracts, will naturally try to convince him that it is costing him a great deal, and will try to charge the electrical equipment with "its share of the burden." He will want it to pay rent and part of the manager's salary, subject it to quick depreciation, make it put aside from one-tenth to one-twentieth of its cost each year for renewal and go on charging interest on the full investment, and in every way try to enhance the apparent cost.

He is not to blame. This is what he is paid for, and he may call attention to some items that might otherwise be overlooked.

But the way for a manager to look at the question is this: It is not a matter of equitable charge between departments. He does not care whether the power is the main product and the heating the byproduct or whether it is the other way around. He should say to himself, if these are the facts, "Here I have a steam plant which I must have anyhow for heating, hot-water service, etc. How much extra will I have to pay out or lose in other ways if I tack some engines and generators on to it?" If he has to rent additional room for them, if they crowd out a department which might make money, the investment should be charged with rent to that extent; otherwise not. If he has to hire more help to take care of them or has to pay the present help more, the investment should be charged with labor; otherwise not. If the manager gets more salary because there is a generating set or two in the basement or if his efficiency in other departments is seriously impaired by reason of the executive ability which he will have to bestow upon this, then the expense of management should be considered; otherwise not. There should be charged, in addition to the fuel and supplies and ordinary upkeep and repairs, the amount of engine, generator, etc., which will be used up annually. That is to say, if the machines will cost twenty thousand dollars and will be used up in twenty years, he will be using up a thousand dollars worth of machinery a year and must charge the investment with it; but he must also credit it with the compound interest on that thousand dollars which is earned every year even if it is not invested at the assumed rate but is used in the business where it earns more. He may consider the chances of obsolescence, i.e., of the machinery becoming so out of date, of something so much more efficient being produced within the assumed lifetime, that he could not afford to run it; but he must also take into account his ability to profit by that increased efficiency. If the investment figures out to pay with machinery now procurable it will certainly pay with machinery so much better as to make it advisable to scrap the old to put it in. He should charge insurance and taxes if he will have to pay any extra; otherwise not. He should charge interest at the rate at which he can get the money and not at what he could make with that amount of money in another department of the business, or on the stock market, for he can get money at the same rate for those purposes. And if with all these charges the investment promises a profit over and above what the cost from the central station would be, and the permanency of the business warrants tying up the amount of money involved for the ordinary lifetime of a plant, he is justified in making the investment; otherwise not.

The Marginal Principle

If a business were making a profit of thirty per cent. per annum on all the money which its owner could raise, he would be foolish to invest a part of such money in a steam plant which would pay a profit of less than thirty per cent. upon the investment.

This is the "marginal principle," the latest bookkeeping device of the central-station solicitor to convince the power user that he can make money by paying the central station more for current than he can make it for himself.

The marginal principle is all right, but it no more proves that a manager should sell his steam engine and electric generator to get money to put into his business than that the owner of a department store should rent instead of own his

building if he can rent at any percentage of the cost of building less than the percentage of profit made by his most profitable department. If the most profitable department is capable of extension and he cannot get money at less than the profit which his electrical plant is paying, then by selling it he can make the difference between the profit made by the electrical plant and that made by his most profitable department. But a man so circumstanced can usually command capital at a less rate than that of the profit which the electrical generating machinery pays when tacked onto a steam plant which he must have anyway and operated in connection therewith.

Improve the Personnel

Myriads of articles have been written and orations delivered at great length on almost every phase of power-plant operation. Automatic devices without number and with more or less worth have been invented, patented and put on the market, with the intention of eliminating in so far as possible the reliance that would ordinarily have to be reposed in the human element. This literature has accumulated and automatics good and bad have been scrapped, while but fragmentary articles appear and desultory attempts are made to improve the efficiency of the plant through the medium of the personnel.

A code of rules, drawn up with the intention of making them fit all conditions and adaptable to all classes of humans, would be worthless and impossible to apply. Different conditions call for different treatment, and man is too complex, with moods too varied, to bring within the application of any such method; but a set of rules intended for the maintenance of discipline—and with proper discipline minor troubles will right themselves—is not only possible to enforce but absolutely necessary to the harmonious operation of the power plant.

A ship without a rudder can be managed and brought into port with a jury rudder, but a plant without discipline is a derelict.

When it is considered that no machine is so intricate as to call for the same delicacy of handling demanded by human beings and that subordinates very often kindle a feeling of resentment toward the "old man," traceable in a large number of cases to ignorance and its handmaid stubborness, it is difficult to blame the chief engineer for any continuity of a disagreeable condition. Still there are very few instances where matters could not be remedied by the application of that valuable reagent common sense reinforced with the higher degree of intelligence accredited to the chief engineer, but which is sometimes sadly lacking.

Consideration of the feelings and working conditions of the help should not be overlooked by the man in charge. Attention and care must be given to any machine if it is to work at its highest efficiency; this is applicable with double force to the human machine. It is unwise, and a dead loss to the plant, for a chief engineer to belittle the ideas of those working under him. Many a successful man owes a major portion of his success to the proper discrimination and application of such suggestions. Some engineers when they graduate from the overall class assume such an air of superiority that they consider a suggestion from a subordinate with scorn. It is such men as these that constantly prate and seem to lament the fact that they are placed in any other category than that of a profession. If those that are so particular about the cognomen of their calling would devote more time to education through the medium of engineering journals and societies, and live up to the same standard of ethics demanded of other professions, they would soon find that, according to their standard of worth, the public would put them in the class to which they rightfully belong.

It would be unjust to the chief engineer to infer that all trouble with employees could be avoided. There are men who in their mental arrangement or derangement are so constituted that no one could work amicably with them. They will malign a chief from pure cussedness, and they cannot accept a consideration of any kind from the boss with the same grace that the courtesy was extended. If any chief is so unfortunate as to secure one of this breed he will soon find that tact and diplomacy will eventually have to give way to harsher means. The man must go. Sometimes it will be noticed that two otherwise good workmen cannot work together in harmony. If the chief cannot reconcile one to the other, the wider he makes their paths of duty the more efficiency will he secure from the individual unit.

There is a class of men, and these are generally found among the ranks of assistant engineers, who resent any show of authority toward them, but who are constantly on the alert for some order from the chief that will give them the appearance of superiority. Such men as these provoke trouble in any plant, as they work on the theory of Milton's devil who preferred to rule in hell than serve in heaven.

A congenial feeling must exist between a chief and his crew if the best work is to be derived from all. This feeling on the part of the chief should not be carried to the extent of making any particular man a favorite or pet, but should be applied impartially; nor should it be interpreted by the help as meaning that they can take privileges that would not otherwise be accorded them. A medium founded on respect, courtesy and consideration can be found that will work to the advantage of the station.

Cleanliness in Power Plants

It is said that a man may be judged by his appearance, meaning by this not necessarily fine clothes but neatness. This rule applies not alone to the human element but to the machine as well. Visible cleanliness about a plant is generally an indication that the internal parts of the machines are also well cared for. This is due not only to the fact that an engineer or fireman who keeps his engine room or boiler room spick-and-span is very apt to pay due attention to the invisible parts, but also if there is no accumulation of dust, oily waste, oil leaks, etc., there is less chance of grit getting into bearings, oil getting into generator windings, or dirty commutators. Attention to such matters requires very little additional time and has a marked effect upon the life of a machine, not to mention the saving in repair bills and increased plant efficiency.

"Never use electricity to do anything that can be done equally well some other way." This was one of the maxims of the late Lord Kelvin, and it illustrates the "horse sense" that made him one of the foremost engineers of the world in addition to being one of the foremost scientists. But the "equally well" mustn't be overlooked.

Misleading or over enthusiastic statements are not restricted to American manufacturers. An English builder of suction gas producers advertises "20 horsepower-hours for 1 penny" of fuel cost, using coke; in other words, one-tenth of a cent per horsepower-hour for fuel. The claim is a trifle over 100 per cent. above the fact.

A jack operated by compressed air and capable of a ten-ton thrust was recently used by the police of New York City to break into a gambling house, forcing open a steel door. And yet it is said there is nothing new under the sun.

The business manager of a certain central station always rammed both hands deep into his trousers' pockets when he went into the generating room of the power house. He wanted to guard against unconscious contact with the teeth of a 2300-volt circuit.

A woman's club out in Nebraska has discovered that bald-headed men are "trusting and confiding by nature." Now it is plain why some engineers are buncoed with imitation goods.

Rowdyism is none the less obnoxious when it is practised by a gang of well dressed ruffians from a technical school.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Mean Effective Pressure

What is meant by the term mean effective pressure, and how is it found?

T. L. R.

Mean effective pressure is the average unbalanced pressure urging the piston forward. There is always some back pressure tending to hold it back and the effective pressure is the difference between the forward and the back pressure. It can be determined accurately only from an indicator diagram, but when the cutoff is known, it may be approximately estimated by the use of the formula

$$M.e.p. = \left(p_1 \frac{(1 + hyp.\ log.\ R)}{R}\right) - p_2$$

in which

$m.e.p.$ = Mean effective pressure;
p_1 = Absolute initial pressure;
p_2 = Absolute back pressure;
R = Ratio of expansion.

Factor of Evaporation

What is the factor of evaporation, and how is it found?

F. O. E.

It is the number by which the evaporation at any given pressure from feed water at the temperature it enters the boiler must be multiplied in order to reduce it to evaporation equivalent to that from and at 212 degrees. It is found by subtracting the number of heat units in a pound of feed water from the number of heat units in a pound of steam at the given pressure, and dividing the remainder by 970.4.

Blowing Out Boilers

Under what pressure is it best to blow all the water out of a boiler?

B. B. D.

It is best to allow the boiler and setting to cool off entirely and allow the water to run out. In this way all of the loose sediment settles in the form of mud and may be washed out by a stream of water from a hose; while if the boiler is blown out while the brickwork is hot the mud is dried, and sometimes baked into a hard mass which is difficult to remove.

Adjusting Corliss Engine Cutoff

When there is but one reach rod from the governor of a Corliss engine to the valves, how are the knockoffs adjusted?

C. E. C.

The rod extending from the governor to the first valve is made right first and then the rod connecting the knockoff of the second valve to the first is adjusted.

Movement of Valve

The shaft of an engine is 15 inches in diameter and the throw of the sheave 5 inches; then if I move the eccentric ⅛ of an inch, how much will that move the valve, providing there is no lost motion?

J. B.

Some authors use the term "throw of the eccentric" to signify the total movement, that is, the diameter of the circle described by the center of the eccentric; others, the "throw or movement of the valve to each side of its central position"; in other words, the radius of eccentricity or the radius of the circle described by the center of the eccentric. The latter use is the more usual and it is assumed that is what is meant by the "throw of the sheave."

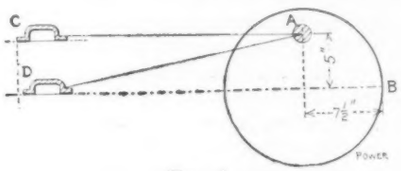


FIG. 1

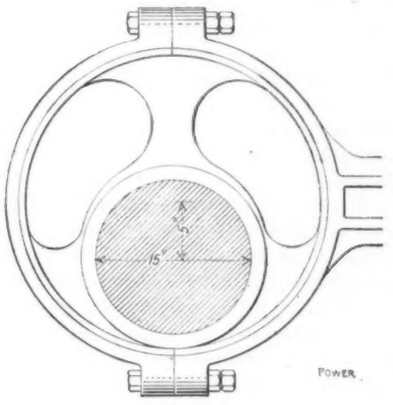


FIG. 2

Suppose a crank pin as at *A*, Fig. 1, in the end of the shaft, and with its center 5 inches from the shaft center. Then it is evident that the center of the crank pin *A* would move $\frac{5}{7.5}$ times as far as a point *B* on the surface of the shaft, and if the shaft were moved forward ⅛ inch, the crank pin would move forward

$$\frac{5}{7.5} \times \tfrac{1}{8} = \tfrac{1}{12}\ inch$$

If this were connected off to the valve in a line square with the line connecting the centers of the crank pin and the shaft, the valve would move as far as the pin; but as soon as the angle of the crank and valve stem departs from a right angle the movement becomes less.

It is easily seen that for a given movement of the crank pin the movement of the valve would be less in the position *C* than in the position *D*, and when the crank pin gets around on the center so that the center line of the crank is in line with the valve stem, it will take a good deal of movement of the pin to make any appreciable movement of the valve.

If the diameter of the crank pin is increased until it embraces the shaft, as in Fig. 2 it is seen that it is also true of an eccentric, the eccentric being but a crank with a pin surrounding the shaft.

Temporary Tube Repair

If one of the tubes in a horizontal return-tubular boiler splits or starts to leak at or near the middle of its length, how may the leak be stopped temporarily?

T. T. R.

A soft-wood plug about six inches longer than the split in the tube may be driven into the tube until the middle of the plug covers the leak. The water will cause the plug to swell and the leak will stop.

Spring Loaded Safety Valve

It is desired to change the blowing point of a spring-loaded safety valve from 100 pounds to 60. How can it be done?

S. L. S.

By changing the spring. The springs of safety valves are not intended to operate at a variation of more than 20 per cent. from the calculated load.

Protecting Handhole Crabs

How may the nuts and crabs on the rear handhole plate be protected from the fire?

H. H. C.

By covering with asbestos or a mixture of asbestos and fire clay.

Notes on the Cost of Industrial Power

Abstract of written discussions upon the papers of Messrs. Parker and Hibner delivered at a joint meeting of the A. S. M. E. and A. I. E. E.

Mr. Peck (Rochester Railway and Lighting Company): Referring to Mr. Parker's paper, other methods of providing for amortization might be mentioned, as, for instance:

1. A yearly sum, equal to the investment divided by the number of years of expected life, should be set aside annually, allowing the variable earnings of this fund to be added to the other earnings of the company.

2. A variable yearly sum, equal to a fixed percentage of the decreasing value of the plant, may be set aside; for example, 10 per cent. of the full value at the end of the first year, 10 per cent. of the remaining value at the end of the second year, and so on. This method would never completely amortize the plant, but would more nearly represent its actual depreciation in value, and leave a relatively small amount to be charged off in one sum at the end of its natural life.

"Inadequacy" should properly be mentioned with obsolescence, as, in general, the same considerations hold good for both conditions. Similarly, "business risk" is an element of fair profit, although not always so associated in one's mind.

The depreciation rate, as fixed by Mr. Parker, on certain details, considered by themselves, is not correct when they are considered as part of a plant; for example, a building which might be in excellent condition after fifty years, probably would not be useful that length of time, nor for a period any longer than the life of the equipment in it.

I emphatically disagree with Mr. Parker's statement that obsolescence has essentially no existence in private power plants, even under stress of competition. If I purchase a plant to furnish power to operate a factory, finance it on a 20-year basis, and in five years' time improved equipment can be purchased with double the efficiency of the original apparatus, a new competitor would be able to undersell me by an annual amount equal to one-half the power cost. It would then be necessary to choose between the loss of one-half the power cost annually, or the unamortized part of the plant, less its sale value.

Considering the subject "fair profit," it should be noted that items of necessity do not have to carry their own burden of profit; for example, an ordinary business cannot be carried on without artificial heat in the winter. The total cost of heating must be carried by the profit-making parts of the business, assuming that heat cannot be purchased from a heating company. Thus the various elements making up the cost of heating must be deducted from the corresponding elements making up the cost of combined heat and power before figuring the actual cost of the power alone.

I have observed that if 100 tons of coal per month are required for heating a building, and if 100 tons are required for power alone, it is often assumed that 110 tons will be sufficient for both heat and power. Where the requirements so nearly balance, this is manifestly not the case, for the heating requirements are distributed throughout the twenty-four hours of the day with a marked peak early in the morning before the power part of the plant begins operation. The power requirements, however, are limited to from eight to ten hours a day, with the peak occurring usually during the warmer parts of the day, or during the late afternoon, when it is permissible to allow the temperature to drop slightly. This means that the coal for combined heat and power may easily amount to from 150 to 175 per cent. of the coal required for either purpose alone.

Mr. Tillman (Consolidated Gas, Electric Light and Power Company, Baltimore): Licensed isolated-plant engineers who are responsible for the entire care and improvements of the power portion of an industrial plant; consulting engineers who are to decide, plan and recommend the type and class of equipment for any given problem of their client; and the central-station industrial engineers who recommend and plan the best and most efficient layout of equipment for their customers or prospective customers, should all work together for one great and important purpose: that of giving to the man who is spending the capital a plant which will produce the greatest return upon the necessary investment.

The return on the investment cannot be estimated offhand, because it includes numerous items which must be taken under careful consideration in each and every proposition. The engineering profession demands an honest decision on all points connected therewith.

The advancement of engineering has been so rapid within the past few years that it is difficult for any one man to be thoroughly posted in all lines of engineering practice which come in the industrial-power work. It, therefore, becomes necessary to weigh all conditions from different viewpoints rather than to recommend past practices. Each and every problem has a right solution, but it requires more than guesswork to solve them and obtain efficient results.

Mr. Norris (National Meter Company): The following figures of gas-engine installation costs are presented to show the economy that can be obtained even down to small sizes when using the gas engine for power purposes. I have selected a few typical plants running on various fuels:

Plant No. 1 contains a 50-horsepower three-cylinder gas engine direct connected to a generator and running on natural gas. An 11-hour service of 300 days per year is furnished at an average load of 15 kilowatts.

Cost of plant installed	$3500	
Interest and depreciation at 10 per cent.		350
Repairs and supplies		175
Labor per year		900
Operating cost, exclusive of fuel		$1,425
Gas bill for year		$315.56
Total yearly charge		$1,740.56
Total kilowatt-hour for year		49,500
Cost per kilowatt-hour		3½ cents

Plant No. 2 contains a 25-horsepower engine belted to a 15-kilowatt generator and one 20-horsepower engine belted to a 12-kilowatt generator, both running on natural gas and furnishing light and power at approximately full load for 365 days per year at 16 hours per day.

Cost of plant installed	$4200	
Interest and depreciation at 10 per cent.		420
Repairs and supplies		210
Labor per year		700
Operating cost, exclusive of fuel		$1,330
Gas bill for year		$1,270.18
Total yearly charge		$2,600.18
Total kilowatt-hours for year		128,480
Cost per kilowatt-hour		2.02 cents

Plant No. 3 consists of one 65- and one 30-horsepower gas engine furnishing power for a manufacturing establishment and running on illuminating gas at 80 cents per thousand cubic feet.

Cost installed	$4375	
Interest and depreciation at 10 per cent.		437.50
Repairs and supplies		220
Labor per year		360
Operating cost, exclusive of fuel		$1,017.50
Gas bill for year		3,279
Total yearly charge		$4,296.50
Total horsepower-hours for year		228,000
Cost per horsepower-hour		1.89 cents

Plant No. 4 consists of one 300-horsepower anthracite producer of the suction type, furnishing gas for two vertical gas engines connected to 100-kilowatt generators; 24-hour service.

Cost installed	$22,000	
Interest and depreciation		$2200
Supplies and repairs		1100
Labor per year		2400
		$5700
Cost of fuel per kilowatt-hour		0.3 cent
Operating charges		0.4 cent
Total per kilowatt-hour		0.7 cent

Plant No. 5 consists of a 300-horsepower anthracite suction producer supplying a four-cylinder vertical gas engine connected to a 200-kilowatt gen-

erator. Fuel used: No. 1 buckwheat at $4 per ton.

Cost installed	$18,000
Interest and depreciation	$1800
Supplies and repairs	900
Labor per year	1500
	$4200
Cost of fuel per kilowatt-hour	0.3 cent
Operating charges	0.63 cent
Total per kilowatt-hour	0.93 cent

I have a record of a three weeks' run on this plant, in which the following figures may be of interest:

Total kilowatt-hours furnished	19,368
Elapsed time, hours	480
Running time, per cent	36
Shutdown time, per cent	64
Average kilowatts	113.85
Percentage of full load	56.9
Coal per kilowatt-hour, including all standby losses, pounds	2.36

In this run no attempt was made to meet test conditions; it represented simply the readings of the instruments and the actual amount of coal supplied to the producer during the time specified.

Plant No. 6 consists of three 200-horsepower producers, supplying one 600-horsepower double-acting tandem gas engine driving a 400-kilowatt generator. The fuel used was Texas lignite, containing 8000 B.t.u. per pound and costing $1.50 per ton delivered; 24-hour service.

Cost installed	$40,000
Interest and depreciation	$4000
Supplies and repairs	2000
Labor per year	3200
	$9200
Cost of fuel per kilowatt-hour	0.169 cent
Operating charges	0.32 cent
Total per kilowatt-hour	0.489 cent

Mr. Timmis (consulting engineer): The equipment of a certain power plant consists of three 250-horsepower water-tube boilers, two 150-kilowatt generators driven by compound engines, one 100-kilowatt generator direct connected to a compound engine, and one 50-kilowatt generator direct connected to a simple engine. Also, two 7½-kilowatt balancer sets. The cost of this outfit was as follows:

Boilers, including settings	$11,190
Engines	12,190
Generators	6,100
Balanced draft	2,325
Steam fitting, including all auxiliaries	6,378
Total cost of plant	$38,183
Cost per kilowatt	$84.85

This plant has been in operation for over three years. It was installed to accommodate a much larger load than it has been called upon to carry; with a capacity of 450 kilowatts, the average load, considering a period of one year, has been 127 kilowatts.

The following table gives the actual cost of running the plant for a period of one year from January 1, 1910, to January 1, 1911:

Wages	$5,233.84
Coal	4,817.69
Water	360
Ashes (removed)	223.24
Oil and waste	164.40
Supplies	159.27
Repairs	263.28
Interest and depreciation on cost of plant, $38,183 at 12 per cent	4,581.96
Total	$15,803.68

Kilowatts metered, 381,500.
Cost per kilowatt, $0.0294 without interest and depreciation.
Cost per kilowatt, $0.0412, including interest and depreciation.

During the year there were 722 hours overtime at time-and-a-half which amounted to $1024.32. This was included in the total amount under wages.

The foregoing figures include the cost of heating the building, the value of which is estimated as follows:

Coal, 585 tons	$1949.75
Two firemen, 30 weeks, @ $15 each	900
Part time of chief engineer	500
Water	30
Removal of ashes	90
Interest and depreciation on boilers of 250 horsepower and distributing panels, $4740, at 12 per cent.	568
Total	$4037.75
Deducting from the total cost of running the power plant for one year, the amount for heating, the cost of running the power plant is	$11,765.93
Actual cost per kilowatt-hour	$0.0323
The cost of Edison service at wholesale rates for the amount of current generated would have been	$17,660.16
As against the cost to operate plant, including all charges	11,765.93
Balance in favor of plant	$5,904.23

Mr. Tompkins, of the Brooklyn & Coney Island Railroad, submitted figures showing that, at the power house of this company, power is delivered at the switchboard for $0.007715 per kilowatt-hour. However, as this did not include interest upon the investment, depreciation, taxes, insurance nor *pro rata* expenses of any of the officials of the company, it is of little value in the present discussion.

Mr. Gasche (Illinois Steel Company): The element of depreciation is unquestionably subject to variant views, but the evidence of past experience of many engineers would indicate that depreciation rates are generally too low. I refer particularly to the rapid changes in the method or process which characterize an industry, thus making a power plant obsolete so far as its primary functions are concerned. To illustrate this: Twenty years ago the simple vertical, long crosshead type of blowing engine was installed at a group of four blast furnaces. About eight years after, half the group of engines was replaced by larger machines with large steam cylinders, so as to operate them as disconnected compound units. In fifteen years' time from the start they were superseded by improved forms of compound engines. About two years ago the new engines were assisted by gas-driven blowing engines using blast-furnace gas, with the implied intention of displacing all steam blowing engines. Now arises the specter of the turbine-driven blower. The point I wish to emphasize is that fundamental changes in the iron and steel business imposed these changes and not the mere "obsolescence" of the elements of the power plant. Nevertheless, they had a short life. Other lines of industry, not excepting the business of furnishing electric current, have exhibited similar crises in their development.

There is another element of growing importance in power-plant investments which may, for the want of a better name, be called "insurance on reliability." This consists of an annual charge that should be set against the gross earnings by the presence of spare units to insure uninterrupted service of the plant for any loads that may be assumed. In some cases a full examination of this "reliability" charge indicates that a mistake has been made in the installation of prime movers of excessive capacity to handle the load.

Mr. Edgerton: For the last year I have been paying particular attention to the cost of electric current as generated in private plants. I have here the data as to costs in one case that may be considered fairly typical in regard to equipment and results for equal output. The plant is of 460 kilowatts generator capacity.

Total engine and boiler-room expenses, 1909-10	$39,894
Total expenses for electric service	12,809.61
Credit for exhaust steam used in heating	3,157.28
Net cost of 461,600 kilowatt-hours	$9,652.33
Net cost per kilowatt-hour	2.091 cents
Interest and depreciation	0.997 cent
Total cost per kilowatt-hour	3.088 cents

The electric service includes lighting, motors driving ventilating fans and vacuum-cleaning service; also, 28.4 per cent. of the heating and hot-water service. The elevator service (six elevators), pumping service, ice machine, sewage ejecter and the remainder of the heating and hot-water services is from other than electric-power sources.

The cost of fuel (pea coal), was $4.20 per ton. The division of the fuel and labor accounts was based upon a series of engine indicator cards, taken over the period of a year.

I notice in Mr. Parker's paper that the selling price of central-plant current is estimated at about three cents per kilowatt-hour. In this locality that figure would not cover interest and depreciation, let alone production and distribution costs.

The rapidly revolving flywheel of a smooth running engine gives no evidence of the tremendous amount of energy stored in it, and few who have never experienced a flywheel accident give the matter a thought. Suppose, instead of a flywheel, the normal operation of your engine required a counterweight of 25 tons or more constantly suspended about 120 feet above your plant and office. Also assume that this weight, by the derangement of the machinery, might be suddenly raised to a hight of 550 feet or even a half mile and then separate in pieces of a ton or more each and fall on your plant. Do you think damage would result? The conditions assumed above are true illustrations of the destructive possibilities of a flywheel when disrupted at normal speed, or when speeded to the bursting point.—*H. S. B. I. & I. Co. Leaflet.*

Governing Waterwheels

The importance of refinement in waterwheel regulation has appeared only in recent years, since electrical accomplishments have made commercially practicable the development of powers previously unregarded and have imposed new and more exacting service upon those which are in use.

For years cotton mills have been driven by water powers with crude governing apparatus, often with none at all; and a cotton mill is regarded as requiring a high degree of uniformity in speed. But a cotton-mill load is also one of the most constant. If the load does not change, a wheel under constant head and gate opening will run at a uniform speed any way, and the small fluctuations made by throwing individual machines on and off are readily taken care of by comparatively simple apparatus.

When, however, a waterwheel is set to driving an electric generator, subject to abrupt and excessive load variations, the degree of regulation required by the most exacting service upon the line can be effected only by a study of conditions to which little attention has previously been paid, and by the use of refined apparatus adapted to control those conditions. A very important factor is the mass of the water already in the penstock; and when, as in many of the large Western installations, this penstock is miles in length and contains tons and tons of water in motion, a partial closing of the gate results in a conversion of velocity into pressure, a pressure generated by the momentum of the column the flow of which it is attempted to restrict, which interferes seriously with the effort of the governor to control the speed. All that the governor can do is to regulate the amount of water flowing to the wheel; but, if its movement to restrain the flow results in a virtual increase in head, its effect is minimized and a complication introduced which may set up all sorts of hunting and racing. The last meeting of the American Society of Mechanical Engineers at Boston was devoted to the presentation by William F. Uhl of his paper upon "Speed Regulation in Hydroelectric Plants," and its discussion. Although the subject is an abstruse one and the paper (which, by the way, had been previously presented at the general meeting of the society and is to be found in the February number of *The Journal*) is forbiddingly mathematical, the hall of the Edison company's building was filled and all of the time available occupied by pertinent and interesting discussion.

The governor is very materially aided by the flywheel effect of the turbine, generator and attached masses and it is often desirable to put on additional weight in flywheel form. The water will drive the shaft only at a certain maximum speed even if its flow is unrestrained. Above that speed the wheel would be running away from the water, so that a flywheel designed with an ample factor of safety for this "runaway speed" is safe from centrifugal force and not subject to practically unlimited acceleration as is the wheel of a steam engine.

Mr. Uhl explains the derivation of the simple formula for the regulation due to any given flywheel effect, and modifies it for the effect of the friction load, change of efficiency, pressure variations, etc. The time factor is of extreme importance. It takes a certain amount of energy to move a gate a given amount. If this is done in half the time, it takes twice the power. The "mechanical" governor, usually belt driven, has only a limited amount of power to expend and must therefore exert that power for a longer time to exert the energy required; and unless the governor is made inordinately massive this time is too long for close regulation with considerable gate movement. With the hydraulic governor of the type in which Mr. Uhl is interested, gates are moved by pistons actuated by fluid pressure under the control of the governor through a pilot valve, and the regulating time for all gate openings, according to the author, is nearly constant.

It is a well known fact that if penstock conditions are disturbed by moving a gate anywhere in the line, a wave will be produced which will proceed along the flume with a certain velocity. In closed penstocks these waves take the form of pressure variations. Vibrations in water travel with the velocity of sound, 4650 feet per second. The penstock walls are flexible, however, and under the influence of pressure variations expand and contract in a rather remarkable degree, producing what is called the "breathing" of penstocks. This has a dampening effect upon the vibrations, and 4650 feet per second may be regarded as the maximum velocity with which any vibrations of pressure in the contents of the penstock will proceed. The time required for a vibration to pass from the gate through the penstock and back to the gate is twice the length of the penstock divided by the rate of travel of the vibration. It is better then not to reduce the time required to operate the gate below this amount, so that the effect of the waves produced may be minimized by the countereffect of the returning waves which will then have time to get back.

A change of velocity of one foot per second will have a very considerable effect upon pressure variation; hence large penstocks and slow normal velocities, which will require small velocity changes for change of load are desirable. They also avoid loss from friction.

Efforts have been made to avoid the difficulties introduced by this impact of the moving body of water when partially arrested, by the use of pressure regulators, in which the pressure is made a factor in controlling the position of the gate. If the gates are closed suddenly and a sufficient amount to disturb the regulation on account of pressure rise, the regulator will be opened by the governor and allow water to be bypassed around the turbine sufficiently to keep the pressure rise within limits.

The pressure drop when the gates are suddenly opened is always less than the pressure rise when they are closed. It may be corrected by the use of standpipes or equalizing reservoirs, the effect of which is to reduce the effective length of the penstock. The minimum hight of such a standpipe must be such that in no case will the water level in it drop to such a point as will admit air into the penstock. Formulas are given for their design. In a plant with long penstocks where it is impossible to install a standpipe, out of the question to increase the size of the penstocks and impracticable to provide sufficient flywheel effect, recourse must be had to a synchronous bypass which discharges that part of the full-load flow of the water which is not necessary to run the turbine with the given load. The full flow is maintained in the penstock, but that not needed by the turbine is switched to the tail race. The same effect is produced in impulse turbines with deflecting nozzles. With a reduced load the flow of water continues uninterruptedly but one or more of the nozzles is deflected so that its jet is discharged into the casing without hitting the wheel.

In discussing the paper, Mr. Warren, of the Lombard Governor Company, said that they found in the tests to which they had subjected it that the formula upon which the paper was based gave results which were too high for load changes of less than 50 per cent. He called attention to the danger of whirlpools with wheels not sufficiently submerged.

The author was asked about the possibilities of electric generators, operating upon changes of voltage rather than of speed, and replied that they had been tried but never with any degree of success. In one case at least the failure was due to the use of liquid contacts and the production of depressions and elevations in the level by quickly repeated movements.

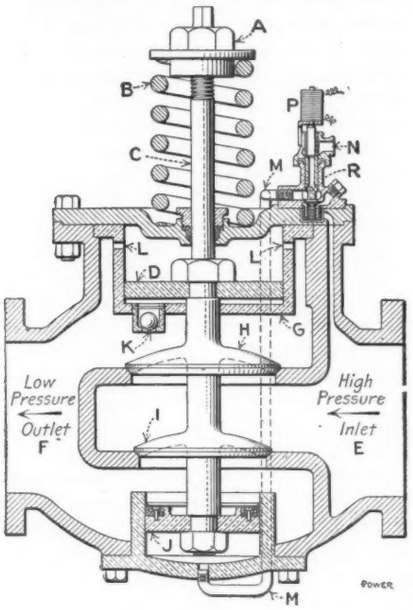
The author had referred to trouble in the draft tube produced by the persistence in its downward movement of the column after the gates had been closed, producing a vacuum behind it into which it returned when its momentum had been spent with a blow which was often productive of disastrous results. One of the auditors told of trouble experienced in the West where the water coming down from the mountain snows often had 1.5 per cent. of entrained air which, under the reduced pressure of the draft tube, assumed a greatly increased volume, and went out in gulps with closings up of the water column, which produced serious shocks. Draft tubes frequently have to be shortened on this account.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

Anderson Automatic Regulating Valve

This valve, illustrated herewith in section, is shown in a closed position. When the spring *B* is adjusted by the nut *A* to the required pressure, the valve disks



SECTIONAL VIEW OF THE ANDERSON AUTOMATIC REGULATING VALVE

H and *I* are forced open. The high pressure side, or inlet, is at *E*. The outlet is at *F*. When the pressure on the low-pressure side has reached the pressure at which the valve, or spring, *B* is set, the pressure, still increasing, is exerted on top of the piston *J* (the valve *H* and piston *D* being balanced), causing the valves *H* and *I* to close.

In order to have the valve open freely and at the same time close very slowly, there is placed a ball check *K* in the bottom of the dashpot *G*. The ports *L*, placed in the upper rim of the dashpot *G*, prevent any accumulation of air while the valve is in service. The water above and below the piston *D* and the air beneath the piston *J* prevent any water hammer and cushion the valve in opening and closing.

The solenoid *P*, which controls the auxiliary valve *R*, is wired to a switch at the pumping station or any other convenient point and, in case of fire, the switch is thrown into contact, which causes the solenoid *P* to open the auxiliary valve *R*, allowing the high pressure from the inlet side of the main valve to pass up through the auxiliary valve and down through the small pipe *M* to the under side of the piston *J*, which causes the main valves *H* and *I* to open to the full area. When the full pressure is no longer required the switch is thrown out of contact. This allows the auxiliary valve to close and the pressure from the under side of the piston *J* returns through the auxiliary valve, exhausting through the port *N*. The pressure being released from under the piston *J*, the main valves *H* and *I* will automatically return to the regulating position without the necessity of readjusting the reducing feature.

This valve is made by the Golden-Anderson Valve Specialty Company, Fulton building, Pittsburg, Penn.

Best High Pressure Pump

This high-pressure double-acting duplex steam pump is shown in Fig. 1 and in a sectional view in Fig. 2. It is manufactured by M. W. Jamieson & Co., Warren, Penn.

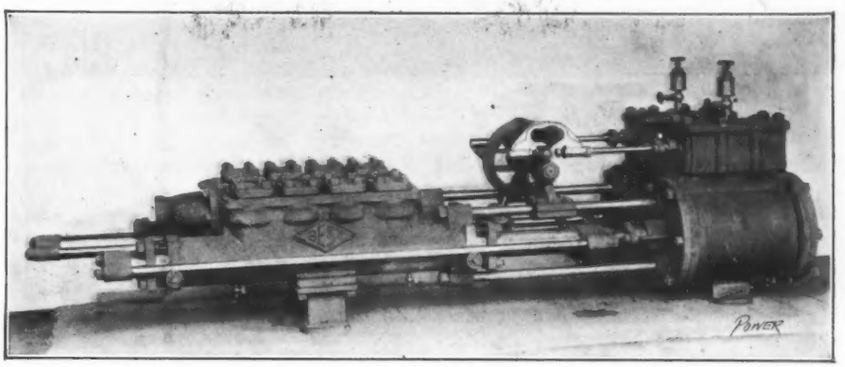


FIG. 1. EXTERIOR VIEW OF PUMP

Both the steam and fluid cylinders are made more than double their necessary strength. Each set of cylinders are separate castings, and are each divided into two compartments, making four distinct and separate pumping heads. The cylinders are tied together by steel rods,

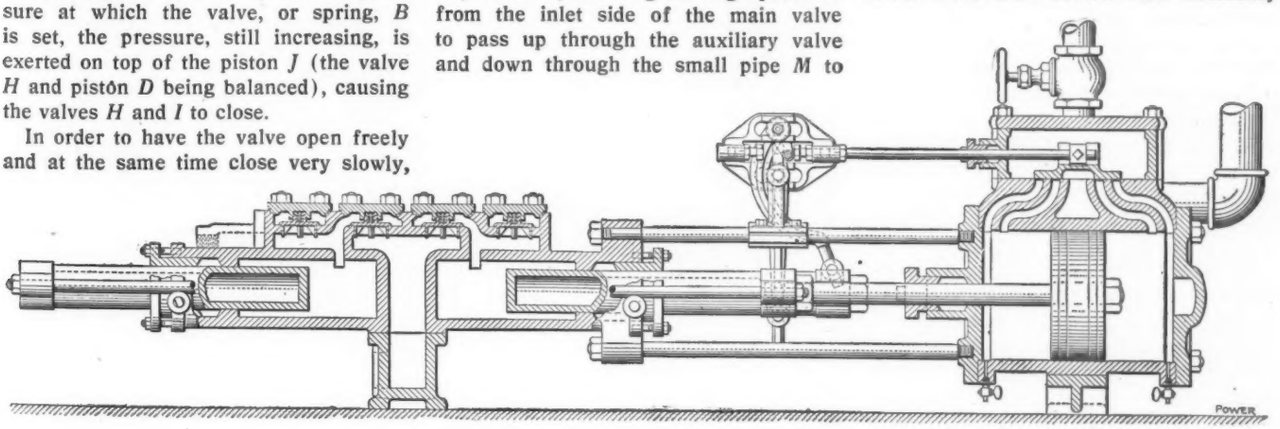


FIG. 2. SECTIONAL VIEW OF PUMP

made extra heavy, to act also as a support to the valve-motion stand. This forms a rigid construction, and yet makes it possible to replace any cylinder if such a necessity should arise.

The arrangement of the steam valves is shown in Fig. 2. The valve plate is machined to receive a valve-stem block, which is finished to allow no play or lost motion. The stem instead of being run through the valve plate and held by a nut is grooved at the end and held in the block by two set screws, the groove making slipping impossible. This arrangement permits the taking out of a valve with the least possible delay. All adjustment is effected outside at the valve yoke by means of set screws held firmly by jam nuts. The motion levers and rocker shafts are situated between the valve stems, thus placing all moving parts out of the way of the operator as well as making it more compact and neat in appearance.

The distribution of the steam, owing to the proper location of the steam ports and to the valve motion, causes the pump to cushion at the end of each stroke regardless of the speed, steam pressure or pressure against which the pump is working. No cushion valve is used, and the pump has a uniform stroke regardless of the pressure.

All water valves are of the self-adjusting, hardened-bronze type, and seat on an absolutely flat hardened-bronze seat. The valve is guided and held in position by a stem situated on the top of the disk. This stem is bored out to receive the spring and operates in a guide cast in the valve cover and projecting down over it. This arrangement completely incloses the spring and makes it impossible for a broken spring to get free and cause trouble. In addition to this, four lugs or wings project down from the bottom of the disk to assist in guiding the valve. The wings are turned off to allow the valve sufficient play to allow a free passage of any foreign matter without breaking the valve. This arrangement for guiding the flat valve with the valve seat allows it to adjust itself perfectly to all wear and makes troublesome grinding unnecessary. Each valve has a separate cover, making it easy to get at each valve independently.

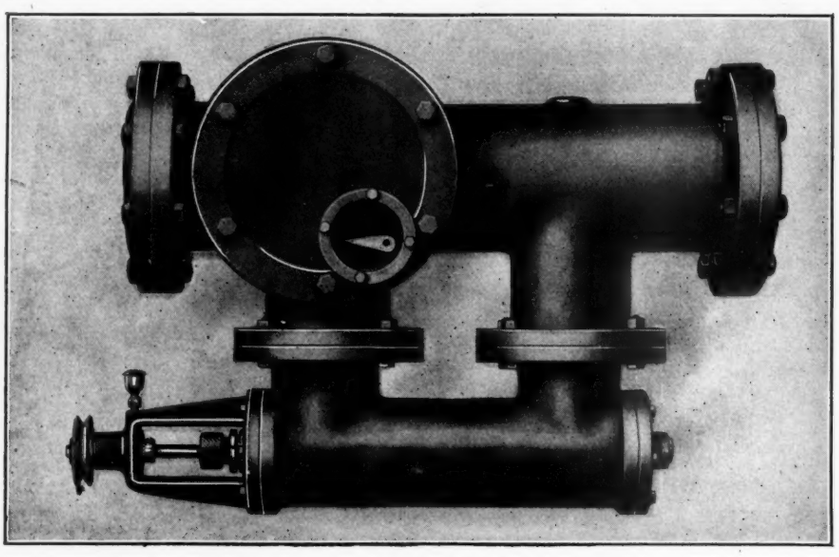


FIG. 1. BELT-DRIVEN WATER CIRCULATOR

The plungers, four in number, are of the outside-end packed type. They are cast in one piece, with extra-heavy flange on the back ends to receive the steel trombone rods which operate the rear plungers. The rods are supported by rollers to secure a perfectly straight and rigid pull and thrust. The power pistons are screwed directly into flanges on the power end so that that end of the pump may be operated independently of the rear end. The plungers are turned and ground perfectly smooth, insuring long life to the packing and preventing loss in fuel by leakage. Plungers may be made brass covered, if desired.

This pump is built to withstand a pressure of from 800 to 1000 pounds.

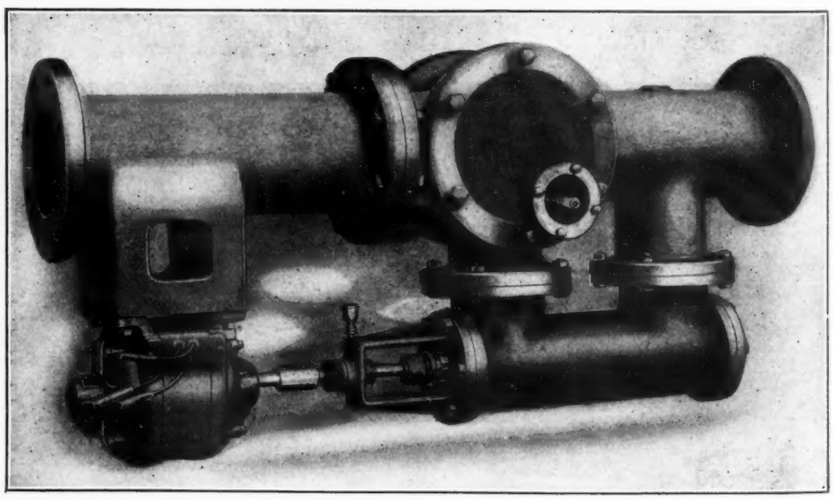


FIG. 2. MOTOR-DRIVEN WATER CIRCULATOR

The Castle Automatic Water Regulator

Recently, hot-water heating systems have been improved by means of a circulating device known as the Castle automatic circulator. It is built in two types, belt driven and with the motor direct coupled to the shaft of the circulator, as shown in Figs. 1 and 2.

This device consists of a small propeller set in the branch pipe that is bypassed from the main return to the boiler and operated by a small electric motor. When ordinary gravity circulation suffices, the circulator is not operated, and it is only necessary to switch off the motor to cut out the circulator. As soon as the propeller ceases revolving an automatic valve cuts off the branch pipe and the water, in returning to the boiler, travels along the main return pipe exactly as though the circulator were not attached to the system. As soon as it becomes necessary to hasten the circulation the motor is switched on, the propeller revolves and the automatic valve takes up a new position, cutting off the main return pipe so that all the returns must necessarily go through the branch pipe and past the propeller.

There are no valves to be set and no attendance is necessary beyond the mere starting and stopping of the motor. In many installations the motor switch is placed at some distance from the circulator. Under ordinary conditions of hot-water heating the circulation depends upon the difference in temperature between the supply and the return lines, and opposed to the difference in head between the two sides of the system is the friction in long lines of pipes, fit-

tings and valves. By circulating the water rapidly, the returns are but a few degrees lower in temperature than the supply lines; consequently, less coal is used to heat them again and the rapid circulation insures the greatest possible efficiency of the radiating surfaces. This rapid circulation is produced by the Castle circulator. It is small in size and design and requires but little power to operate it. It need be run but a short time per day and as soon as it is stopped, expenses cease. Sudden temperature drops are met by the circulator and it is not necessary to maintain an extra hot fire.

There are many actual examples of coal saving by means of this system.

Unsatisfactory results from heating systems installed with piping of insufficient size or with many sharp angle turns can be prevented. This circulator is made in three sizes and is manufactured by the American Auxiliary Heating Company, Boston, Mass.

Sea View Plant Changes Hands

Among the improvements to be made by the Sea View Railroad Company, which has recently been purchased by President Sherman, of the Providence & Danielson Railroad, will be the enlargement of its power plant. A new 500-horsepower Babcock & Wilcox boiler has been ordered, and a new 125-foot brick chimney will be erected, to supplant the two sheet-iron stacks now in use. When the new boiler is installed the plant will have a capacity of 1400 horsepower. The Sea View company operates a trolley line from East Greenwich to Wickford, Saunderstown, Narragansett Pier and Wakefield, R. I. The main office is in Providence, R. I.

Institute Organizes First Branch

The members of the Institute of Operating Engineers of New York City and vicinity, with the exception of the Long Island members, met at the national headquarters on Saturday evening, March 18, and organized the first branch in New York State, which will be known as Branch No. 1 of District 2 of the I. O. E.

The election of officers resulted as follows: Branch chairman and branch representative, Willis Lawrence, chief operating engineer of the Interborough Rapid Transit Company; secretary-treasurer, W. P. F. Hill, chief engineer, Woman's Hospital; chairman of committee on education, F. C. Flickinger; chairman of committee on apprenticeship requirements, L. M. Glodell, chief engineer in the United States Express Company building.

Thirty-five members of the branch were present at the meeting and much enthusiasm was shown by the speakers. The organization starts out with about 80 members all told, and will in the future conduct the New York City meetings for the presentation of papers.

New Chemists' Building

The Chemists' building, which was inaugurated on March 17 at 50 to 54 East Forty-first street, New York City, is believed to be the first of its kind in the world. It combines the features of a first-class club, including restaurant and members' bedrooms, with finely equipped laboratories for analytical and consulting chemists and for investigators in pure and applied science, not to speak of a carefully planned scientific lecture room, a large library and scientific museum.

The building occupies 56x100 feet and cost upward of half a million dollars. It is owned by a stock company, whose shares have been taken by prominent chemists and by individual manufacturers and companies whose business largely depends upon chemical process, and who have realized that industrial progress depends upon scientific research. While it is expected that the building will be more than self-supporting, the shareholders limit themselves to 3 per cent. dividends, all surplus to be devoted to the betterment of the building and to the ultimate benefit of the science. The chief tenant is the Chemists' Club, which occupies the lower half of the building.

Engineering Societies Protest to Public Service Commission

A committee representing five engineering organizations—the International Union of Steam Engineers, the National Association of Stationary Engineers, the Marine Engineer's Benevolent Association, the New York Engineer's Protective Society and the Blue Room Engineering Society—have presented a letter to the Public Service Commission and to Mayor Gaynor protesting against the alleged discriminating rates employed by the New York Edison Company. It was claimed that nearly one-half of the electric current sold in the Boroughs of Manhattan and Bronx by the Edison company is charged at a rate over 300 per cent. greater than the average rate charged for the remainder, and that 30 per cent. of the total current sold is disposed of at a rate less than the *pro rata* interest and depreciation charge; hence these charges are carried by the small consumer paying 10 cents per kilowatt-hour. Accompanying the letter of protest was a petition signed by over two hundred and fifty small consumers, asking for legal action to prevent the alleged discrimination.

Nearly 400 employees were thrown out of work for about two days by the blowing out of the cylinder head of the main engine at the Consumers Rubber Company's factory at Bristol, R. I., on March 15. A new head was cast in Providence.

NEW PUBLICATION

MATHEMATICS FOR THE PRACTICAL MAN. By George Howe. Published by D. Van Nostrand Company, New York, 1911. Cloth; 143 pages, 5½x8 inches; 42 illustrations. Price, $1.25.

Beginning with the fundamentals of algebra, elementary geometry, plain trigonometry, analytical geometry and calculus are taken up in order. The book has been kept within the limits of its title and no attempt has been made to go deeply into these subjects, only such portions being covered as are essential to the needs of the engineer. The author is to be complimented upon the simple yet adequate treatment of the subjects, which should enable anyone of ordinary intelligence and having a fair knowledge of arithmetic to acquire a working knowledge of them. Having made such a good start, it is to be regretted that the author did not go a step farther and include a number of engineering problems showing the application of the pure mathematics to the practical cases. This would have materially increased the value of the book to the practical engineer.

SOCIETY NOTES

On Thursday evening, April 13, the regular monthly meeting of the Institute of Operating Engineers will be held in the Engineering Societies building, 29 West Thirty-ninth street, New York City, commencing at 8 p.m. sharp. J. C. Jurgensen will deliver a paper on the "Economical Aspects of the Institute of Operating Engineers." This will be discussed by prominent engineers.

The American Electric Railway Manufacturers' Association announces the opening of the offices of this association at room 1002, 165 Broadway, New York City. This office will be the official headquarters of the association, and all members are cordially invited to visit same, out of town members being welcome to use this headquarters for the receipt of their mail and for carrying on correspondence, etc., while in the city.

The problem of making the earth yield an increase adequate to supply the needs of the population will be considered on Tuesday evening, April 11, at a meeting of the American Society of Mechanical Engineers, in the Engineering Societies building, 29 West Thirty-ninth street, New York, when a paper upon the "Economic Importance of the Farm Tractor," by L. W. Ellis, will be presented. Following this paper, Dr. Charles E. Lucke, professor of mechanical engineering of Columbia University, will give a talk on the mechanical equipment of farm tractors which will be illustrated by views taken last summer at the Canadian industrial exhibition held in Winnipeg, Manitoba.

The Cleveland branch of the American Chemical Society at its March meeting was addressed by W. R. Hulbert, manager of sales, Goldschmidt Thermit Company, on the thermit-welding process. In addition to a general description of the process and its various applications, with lantern slides, Mr. Hulbert gave a demonstration of thermit welding, comprising a number of experiments to show how the process is used commercially for repairing wrought-iron and steel sections, and for welding pipes up to 4 inches in diameter. Much interest was shown in the demonstration, which was witnessed not only by the local members of the American Chemical Society, but by members of the American Society of Mechanical Engineers and others who came from cities as far out as Akron and Lorain and towns in the vicinity of Cleveland.

PERSONAL

The Crocker-Wheeler Company announces the appointment of Clarence E. Delafield, *vice* R. N. C. Barnes, resigned, as district manager with headquarters at the company's offices in the Boston Safe Deposit and Trust building, 201 Devonshire street, Boston, Mass.

H. H. Laughlin has been placed in charge of the branch office recently opened in Pittsburg, Keystone building, 324 Fourth avenue, by the Richardson-Phenix Company, of Milwaukee, Wis. Mr. Laughlin has been with the Richardson-Phenix Company for several years and is familiar with the methods of lubrication of all kinds of machinery.

At a recent meeting of the board of directors of the Pawling & Harnischfeger Company, Milwaukee, Wis., S. H. Squier, who has been with the company for a number of years, was elected secretary and a director of the organization. W. H. Hassenplug, sales manager, was elected a director and second vice-president, and F. P. Breck, also associated with the company for many years, was elected a director.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

TURBINE. Gustaf de Laval and Ernst Elis Fridolf Fagerstrom, Stockholm, Sweden. 986,472.

INTERNAL COMBUSTION ENGINE. Nelson Edward Davies, San Francisco, Cal. 986,552.

ROTARY ENGINE. Thomas H. Lindley, Cedar Rapids, Iowa, and Herman Schneier, Sheboygan, Wis. 986,636.

ROTARY ENGINE. William L. Merrill, Portland, Me. 986,641.

WAVE POWER GENERATOR. Robert Max Morius, San Diego, Cal. 986,740.

WAVE AND CURRENT MOTOR. Joseph T. Cross, San Francisco, Cal., assignor to Frank H. Howard, San Francisco, Cal. 985,802.

FLUID-OPERATED TURBINE. Eric Brown, Baden, Switzerland. 986,902.

CURRENT MOTOR. Lincoln Guynn, Seattle, Wash. 986,919.

ROTARY STEAM ENGINE. Robert I. Miller, Sandusky, Ohio, assignor of sixteen and one-third one-hundredths to William F. Thomas and sixteen and one-third one-hundredths to William J. Duffy, McMechen, W. Va., and sixteen and one-third one-hundredths to Martin J. Malooley, Wheeling, W. Va. 986,932.

TURBINE. Charles Algernon Parsons, Newcastle-upon-Tyne, England. 986,942.

STEAM ENGINE. Nathaniel Greene Herreshoff, Bristol, R. I. 986,982.

BOILERS, FURNACES AND GAS PRODUCERS

STEAM-GENERATING PLANT. Minott W. Sewall, Roselle, N. J., assignor to the Babcock & Wilcox Company, Bayonne, N. J., a Corporation of New Jersey. 986,648.

STEAM-GENERATING PLANT. Minott W. Sewall, New York, N. Y., assignor to the Babcock & Wilcox Company, Bayonne, N. J., a Corporation of New Jersey. 986,649.

ARTIFICIAL-GAS BURNER. Jacob Weintz, Cleveland, Ohio, assignor to the Strong, Carlisle & Hammond Company, Cleveland, Ohio, a Corporation of Ohio. 986,663.

HYDROCARBON BURNER. Virgil H. Mills and John H. T. Mills, Hubbard, Tex. 986,739.

STEAM BOILER. Charles William Todd, Manchester, N. H., assignor of one-third to Lewis W. Crockett, Manchester, N. H., and one-third to D. Arthur Burt, Boston, Mass. 986,876.

MECHANICAL STOKER. Levi F. Torrey, Buffalo, N. Y., assignor to Margaret E. Torrey, Buffalo, N. Y. 986,877.

FURNACE. Carl Wegener, Berlin, Germany. 986,881.

FURNACE. Harry Moor, Philadelphia, Penn. 986,934.

HYDROCARBON BURNER. Rudolph Hoffman, Battle Creek, Mich., assignor to American Stove Company, St. Louis, Mo., a Corporation of New Jersey. 987,067.

POWER PLANT AUXILIARIES AND APPLIANCES

VALVE MECHANISM. William K. Rankin, Philadelphia, Penn., assignor to John E. Reyburn, Philadelphia, Penn. 986,592.

AUTOMATIC DAMPER REGULATOR. William J. Turner, Providence, R. I., assignor to Putnam Foundry and Machine Company, Providence, R. I., a Corporation of Connecticut. 986,658.

THERMOSTATIC VALVE. Frederick W. Robertshaw, Pittsburg, Penn. 986,760.

ENGINE GOVERNOR. John W. Sargent, Providence, R. I. 986,762.

VALVE. Conrad C. Schoeneck and Ivar F. Warme, Syracuse, N. Y. 986,765.

STEAM, AIR AND WATER-TRAP VALVE. John E. Boegen, Berwyn, Ill., assignor to Charles P. Monash, Chicago, Ill. 986,797.

CENTRIFUGAL PUMP. Franklin H. Jackson, West Berkeley, Cal., assignor to Byron Jackson Iron Works, West Berkeley, Cal., a Corporation of California. 986,827.

LUBRICATING DEVICE. John Christopher Nichol, Ottawa, Ontario, Canada. 986,849.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRIC SWITCH. Horace Hull, Denver, Colo. 986,714.

DYNAMO ELECTRIC MACHINE. Carl M. Page, Chicago, Ill., assignor of one-half to Horace D. Reynolds, Chicago, Ill. 986,748.

ELECTROPLATING MACHINE. John W. Heaphy, Philadelphia, Penn. 986,823.

ELECTRIC SWITCH. Columbus Woods and Whitman H. Sayles, Peoria, Ill. 986,958.

SAFETY COUPLING FOR ELECTRIC CONDUCTORS. Angel Belgorder, Mexico, Mexico. 987,036.

DYNAMO ELECTRIC MACHINE. James Burke, Erie, Penn., assignor to Burke Electric Company, a Corporation of Pennsylvania. 987,044.

POWER PLANT TOOLS

WRENCH. Peder Roisum, Edmore, N. D. 986,593.

LIFTING JACK. Jotham B. Taylor, Auburn, N. Y. 986,781.

JACK. Ralph F. Schofield, Olathe, Kan. 986,868.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Col. E. D. Meier; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting in Pittsburg, May 30 to June 2.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff; sec., T. C. Martin, 31 West Thirty-ninth St., New York. Next meeting in New York City, May 29 to June 2.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Commander U. T. Holmes, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held September, 1911, in Boston, Mass.

WESTERN SOCIETY OF ENGINEERS

Pres., O. P. Chamberlain; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill. Meeting first Wednesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., Walter Riddle; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Pres., R. P. Bolton; sec., W. W. Macon, 29 West Thirty-ninth street, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio, September 12-15, 1911.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June 5-10, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting at Detroit, Mich., January 15-19, 1912.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.

Pres., Arthur J. Frith; sec., Charles Kratsch, 416 W. Indiana St., Chicago. Meetings the second Friday in each month at Fraternity Halls, Chicago.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; acting sec., Charles P. Crowe, Ohio State University, Columbus, Ohio. Next meeting, Youngstown, Ohio, May 18 and 19, 1911.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May 23-26, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

sunny little corner of the offices of the Hill Publishing Company is occupied by the advertising service department:

The department that is responsible each week for this page.

This corner overlooks the site of the new Municipal Building of New York, which, when completed, will be thirty-two stories high.

For more than three years a multitude of men has been excavating, sinking caissons to the backbone of Manhattan Island.

Gripping the rock with that strength which will be necessary to uphold the towering mass of steel.

A short time ago, not more than two months, the foundations were completed and in the period already elapsed the framework has been raised nine stories.

The probabilities are that the building will be completed in about half the time that it took to sink and fasten the foundations.

The mere mechanical part of the work, the raising of the framework and filling it up with concrete, brick and woodwork, this is the quickest part of the construction.

It is the fighting against the deep laid irregularities of strata, making the earth uphold its end of the great undertaking, that takes up time and often causes trouble and expense.

This state of affairs exactly illustrates the old view of most people toward advertising.

A man might have had an excellent article and reasonable prices, but he first had to blast his way through the deep-seated prejudice against newly advertised articles, articles that didn't have years of references behind them.

He had to make the people buy *against their wills.*

If he had a *good* article and persevered, his later success would be as rapid in proportion as the erection is to the foundation of the building.

But in the meantime much valuable time would have been lost.

This attitude of the buyer has now changed, and the reason for the change is pretty well covered by Chas. E. Bellatty in an article in "Printer's Ink."

He says: "It is no exaggeration to say that the advertising columns of many of the magazines are more carefully edited than are the columns containing literary matter. No longer is it necessary for an advertiser to give bank references. The publisher's guarantee means much more."

Which applied to the engineering profession means just this:

Keep in touch with the well established concerns that advertise in your technical paper. Their reputation and the fact that they advertise regularly are significant enough.

But, on the other hand, keep an eye out for new concerns with new articles to offer.

And if they show in straightforward, convincing, reason-why copy that they can save you money or time, or can increase the efficiency of your plant—

Give them a trial. Send for catalog or descriptive matter and get full particulars.

In this manner you will miss no opportunities.

You will not lose the time which is necessary in putting up a building, but is unnecessary in advertising.

In so far as knowing the best equipment and accessories for your plant,

You will be thoroughly up-to-date.

BUSINESS ITEMS

Birch, Riley & Co., of New York city, sales agents for the Universal stoker, have opened a Boston office in the Oliver building, 141 Milk street, room 954, where Charles H. Sammons, M. E., will have his New England headquarters.

Two 6-inch Swartwout vertical receiver steam separators have recently been sold by the Ohio Blower Company, of Cleveland, Ohio, to the Michigan Paper Company, Plainwell, Mich., and a 12-inch vertical upcurrent oil separator to Endicott-Johnson Company, Endicott, N. Y.

The Liberty Manufacturing Company and Elliott Company, of Pittsburg, Penn., manufacturers of power-house accessories, have removed their New England office to room 954, Oliver building, 141 Milk street, Boston, where their representative, Herbert E. Stone, will be glad to see their customers and friends.

Edward F. Hughes, for many years connected with tue waterworks business, at present a water commissioner of Watertown, and well known throughout New England as the representative of the Chapman Valve Company, has opened an office in room 954, Oliver building, 8 Oliver street, Boston, where he will engage in the artesian and driven well business, making tests for foundation work, geological research and water supply for manufacturing, public or private purposes.

NEW EQUIPMENT

Complete modern equipment will be installed in the Auburn, Ind., electric-light and water plant.

The Friends Almshouse, 316 Walnut street, Philadelphia, Penn., will install an engine and dynamo.

Rouleau, Sask., Canada, is calling for two tenders for electrical machinery and for producer-gas plant.

The Defender Photo Supply Company, Rochester, N. Y., will double the capacity of its power plant.

The Mansfield (Mass.) Bleaching Company intends adding about 300 horsepower to its steam equipment.

Newport, Cal., is planning the erection of a municipal lighting plant. About $50,000 will be expended.

The Southern Power Company is erecting a 10,000-horsepower auxiliary plant at Greensboro, N. C.

Power-plant equipment will be required in the new hotel to be erected at Portland, Ore., by C. Lowengart.

The Westport (Conn.) Water Company is planning to duplicate its present equipment at its power station.

Dr. W. M. Hunt, of Draper, S. D., is planning the installation of an electric-light system for the town.

The Canadian General Electric Company, Peterboro, Ont., will erect a $250,000 addition to its factory.

J. H. Hart, Danbury, Iowa, will install an ammonia refrigerating plant in connection with meat market.

J. Schlotter, La Mesa Springs, Cal., is contemplating the erection of an ice plant to cost about $14,000.

The Citizens Heat and Light Company, Elwood, Ind., will spend $100,000 on improvements at its plant.

Saskatoon, Sask., Canada, is asking for bids for electric generators and a 1250-horsepower Corliss engine.

The Alberni District Electric Light and Power Company will equip a large power plant at Alberni, B. C.

The Valley Ice and Laundry Company, Hemet, Cal., will install additional ice-making and laundry machinery.

Fire did about $8000 damage to the plant of the Northern Westchester Lighting Company, at Ossining, N. Y.

The substation of the Idaho Consolidated Power Company, Pocatello, Idaho, recently destroyed, will be rebuilt.

The Wetherbee Brothers, Arlington, Mass., is in the market for a 60-light, 110-volt generator and storage battery.

Smith & Hill, of Mobridge, S. D., have applied to the council for a franchise to install an electric-light plant.

Improvements will be made at the power and light plant at the Muskingum county Infirmary, Zanesville, Ohio.

Souris, Manitoba, will spend $95,000 for new waterworks equipment, including gasolene engines, pumps, compressors.

The Union Meat Company, of Portland, Ore., will install a new cold-storage plant at its branch house in Medford, Ore.

The city of Philadelphia, Penn., is receiving estimates for new boilers and repairing old boilers at the General hospital.

The Myer-Moran Company, 210 North Holliday street, Baltimore, Md., engineers and machinists, would like catalogs of pumps.

The Dallas (S. D.) Light, Heat and Power Company has been granted a franchise to construct an electric-light and power plant.

Power-plant equipment will be required in the new hospital building to be erected by the El Reposo Sanitorium Company, Los Angeles, Cal.

Power-plant equipment will be required for a new hotel to be erected by W. E. Bush, Fresno, Cal. About $150,000 will be expended.

Power-plant equipment will be required in the Terminal hotel to be erected at San Francisco, Cal. William Curlett & Sons are architects.

Fire caused $25,000 damage at the substation of the Edison Electric Light and Power Company, on Homer street, Newton Center, Mass.

The Farmers & Merchants Club, Calexico, Cal., is planning to establish an electric-lighting plant in connection with the city water plant.

A. L. Brewer and J. S. Lewis, Ogden, Utah, have been granted a franchise to construct and operate an electric-lighting, heat and power system.

Wheaton Seminary, Norton, Mass., will install additional boiler, also steam engine and electric-light equipment for new buildings and fire pump.

The San Joaquin Light and Power Company, Fresno, Cal., is planning to install a number of electric pumping plants in the vicinity of Corcoran.

The Clarendon Power Company is being formed at Springfield, Vt., with L. B. Dow as president. The concern will build a power plant at Clarendon gorge.

A central power plant will be installed for the two high-school buildings to be erected at Fullerton, Cal. N. F. Marsh, architect, Los Angeles, is preparing plans.

The Dominion Power and Traction Company, Hamilton, Ont., will install new generators and turbines. Will also equip a new power station at Brantford, Ont.

W. B. Allen and Henry Stroven, of Holtville, Cal., are at the head of a company which will establish a large creamery and cold-storage plant in that vicinity.

The R. J. Reynolds Tobacco Company, of Winston-Salem, N. C., is considering the purchase of vertical fire-tube boilers for the Richmond branch factory. S. F. Brown, chief engineer.

The Northern Ontario Light and Power Company, of Toronto, Canada, will locate branches in different parts of Ontario and will need a large quantity of steam and electric equipment.

Hubert E. Collins, consulting engineer, 110 West Thirty-fourth street, New York, is in the market for three 4-inch steam separators, one 125-horsepower and two 200-horsepower return tubular boilers, electric motors.

The Dennison Manufacturing Company, of South Framingham, Mass., is contemplating the installation of two new 75-horsepower boilers in the building owned by it at Roxbury, Mass., and known as the Roxbury tag factory.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEERS WANTED to solicit for the Rolin patent adjustable grate. Apply Standard Grate Co., Heed Bldg., Philadelphia.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

COMPETENT AND EXPERIENCED stoker erectors at once; state age, reference, experience and salary expected; give full details. Box 408, POWER.

SALES AGENTS to sell steam turbine blowers, feed water regulators, ventilating fans, pumps, etc.; guaranteed territory; commission. Wing, 90 West St., New York City.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

ENGINEERING SALESMAN wanted to take charge of New York office for sale of centrifugal pumps and blowers; should be a graduate engineer; write, giving age, experience, references and salary wanted. Address Box 403, POWER.

WANTED—A competent man to do general inspection work for a liability insurance company; must be qualified to assist and instruct other inspectors; expert knowledge of elevators required. Address, stating experience, education, age and whether married or single, Box 399, POWER.

WANTED—A technical power plant engineer with actual experience in producing efficiency results, also must be familiar with refrigeration essentials; a man who can fill the above requirements can secure a fine position with one of the largest firms in the city of Rochester, N. Y. All communications held confidential. Lock Box 596, Rochester, New York.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEER, second class, desires change; good reference from large factory electrical plant. "S. T.," Care POWER.

WANTED—Position by young married man, familiar with a.c. and d.c. in parallel and all makes of engines and boilers; references. Box 380, POWER.

STEAM ENGINEER and blast furnace master mechanic desires to locate with construction or repair department, erecting steam plants and general machinery, or maintaining same. Box 407, POWER.

TECHNICAL MAN, twenty-four, mechanical, electrical, refrigeration, four years' practical station work, experienced electrician, contractor, solicitor, desires connection ice and light plant, preferably in latter capacities. Box 405, POWER.

ELECTRICIAN and first-class elevator mechanic, drum and traction cars, make all repairs, take charge of plant or building; 15 years' all-around experience; best references; married; want steady position. Reply "G. A.," 610 Linwood St., Brooklyn, N. Y.

WANTED—Permanent position as chief or operating engineer in a.c. or d.c. central station; experienced in steam, automatic engines, boilers, pumps and dynamo electric machinery up-keep; I. C. S. diploma, electric lighting and railways course; strictly temperate, steady and careful, mechanic; age 24; five years' experience; give salary, conditions and nature of plant; references. Address P. O. Box 162, Grampian, Penn.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

PATENTS—IDEAS WANTED — Manufacturers want Owen patents. Send for three free books. R. B. Owen, Dept. 43, Washington, D. C.

AN EXPERIENCED SALESMAN desires to take on a side line of approved steam specialties for the Pittsburg district. Address Box 406, POWER.

WANTED—Management of New England branch office for a few high-grade steam specialty houses wishing to promote their business in this territory. Address "R. H. L.," POWER.

ELECTRICAL ENGINEERING—We guarantee to give a thorough tuition in electrical engineering for $10 only; fees returned if not satisfied. Write us before paying more. Box 811, Cincinnati, O.

A WELL KNOWN and reliable concern in Hungary, with ample capital, wishes to represent American builders of oil and gas engines (producer gas) and other machines. Address Box 401, POWER.

REPRESENTATION—An established sales agency handling power plant equipment for Pittsburg district wishes to add open feed water heaters, steam and oil separators and traps. Address Box 404, POWER.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

POWER PLANT engineers and mechanics everywhere will be paid liberally for information, strictly confidential, on improvements requiring new chimney, to assist us securing contract; we do the rest and you make some easy money. Address Construction Co., 1307 Manhattan Bldg., Chicago, Ill.

PNEUMATIC TOOLS, German manufacturing company, Europe's largest and leading concern in compressors and pneumatic tools, having developed these lines to a perfectness exceeded by no other manufacturer in the world and enabling it to meet every competition is contemplating extending its sales to the United States and therefore solicit correspondence from America. Box 409, POWER.

DIRECT-CONNECTED GENERATORS: 75 kilowatts, 220 volts to Ideal engine; 350-kilowatt alternator to compound engine; belted generators, 85 kilowatts 110 volts, 175 kilowatts 240-volt alternator, 225 kilowatts 220 volt; boilers, 50 to 500 horsepower; Corliss engines, 16x42, 22x42, 26x42, 19x38x48 cross compound, other engines; 45-horsepower Fairbanks-Morse gas engine, 1500-horsepower open heater. Hugh W. Dyar, 204 Dearborn St., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

HIGH-SPEED SAFETY ENGINE and dynamo, both in A-1 condition; will sell cheap. Box 410, POWER.

FOR SALE—Saunders power pipe machine to take 2½ to 8 inches, complete with dies, guides, countershaft, etc., in first class condition. Address "K," POWER.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Pair of Crosby steam engine indicators with extra springs, scales, etc., in mahogany box; Crosby reducing wheel, one three-way cock and two straight-way cocks; all in perfect condition; price $75. Address W. B. Lewis, 732 Banigan Building, Providence, R. I.

FOR SALE—Mill property, price $4200, at Baleville, Sussex county, N. J., 75 horsepower water power with present dam, and good stream flow for manufacturing purposes, four story mill building about 50x35 feet, older three story mill building about 25x60 feet, two dwelling houses, barn and about ten acres; railroad adjoining; to be sold to close an estate, and bargain at price. Address Linn Realty Company, Hamburg, Sussex county, New Jersey, or 115 South 42d street, Philadelphia, Penn.

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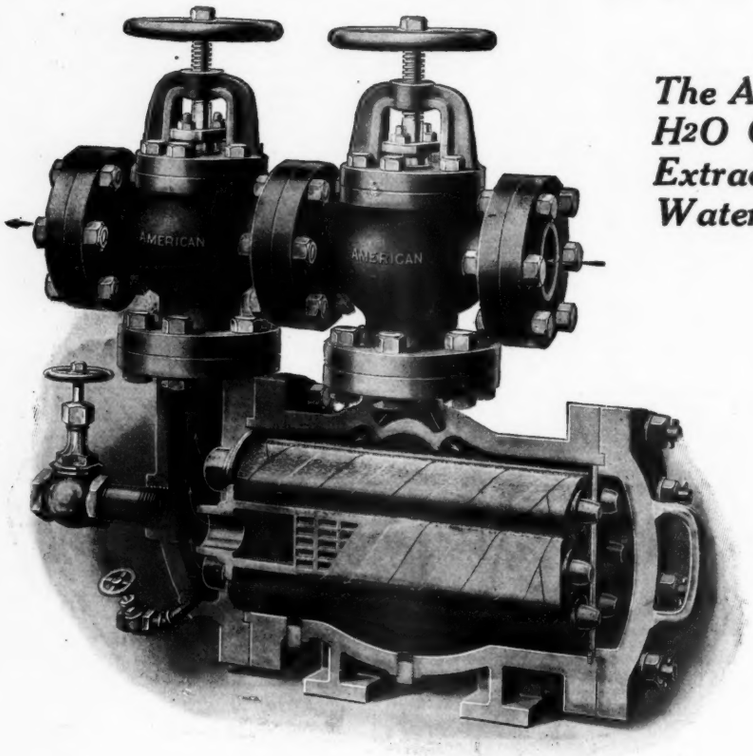
Removes ALL the Oil and Grease from the Condensation



The American H2O Grease Extracting Feed Water Filter

Advantages

1. It has a filtering surface equal to 320 times the area of the feed water pipes — a greater area than ever before obtained.
   This feature assures positive filtration at all times and under all conditions.
2. It has few parts and each part is easy to get at.
   Renewals and changes can be made quickly and with ease.
3. It has a device for applying a reverse current of steam for temporary cleaning.
4. The whole construction is along the most simple lines, making for great efficiency and long life.

It insures the removal of every last particle of grease or oil from the condensation before it gets into the boiler.

Prevents all chance of bagging due to oil in the boilers and consequently removes not only a source of great expense but of great danger as well. Bagging plates are always sure signs of coming trouble.

If you are using condensation for boiler feed, this filter will save you repair expenses, make it easier to keep up steam, reduce boiler wear and tear, save you coal, and give you a much *safer* plant. Complete details of this and our other steam specialties on request.

American Steam Gauge & Valve Mfg. Company

New York Chicago Boston, Mass. Pittsburg Atlanta

The salary-raising story told in the pictures is based upon hundreds of actual instances where engineers have secured promotion because they were regularly using

American-Thompson Improved Indicators

Price $55—$5 Down—$5 Monthly

When an engineer can show his employer that due to his efforts overhead expenses are being lowered, promotion is bound to follow.

Because better results at lower cost are proof of ability and merit. And you cannot convince your employer that you deserve more money if you can't show him proof.

The engineer who owns an American-Thompson is thoroughly familiar with his engine; he can prove in a minute that the valves are adjusted properly, that there are no steam leaks in the cylinder, that his end of the business is being tended to properly, at lowest possible cost.

Put that kind of evidence before YOUR boss and you'll be able to convince him that YOU are worth more money. At any rate it will make your job SAFE and it will help you when you apply for a better one.

The price and the terms of this Quality Indicator are easily within your means—Price $55.00—Terms $5.00 down—$5.00 monthly.

Send your first payment today and we'll ship your American-Thompson at once. You can examine it five days.

But don't delay—send the $5.00 today by registered mail or money order. And kindly mention Proposition number 103 when writing.

MAIL THE COUPON

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

Send me full details of your Indicator Offer No. 103.

Name .....

Address .....

City and State .....

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"How hot?" is the principal question that the steam engineer has to answer.

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"How hot" can be answered if you have one of these first-class improved Cochrane thermometers. This thermometer is fitted with a nickel-plated, metal carrying case, with a chain and safety-pin, and has been especially designed for the use of the stationary engineer. **For a limited time it will be sent, together with a copy of our treatise on the**

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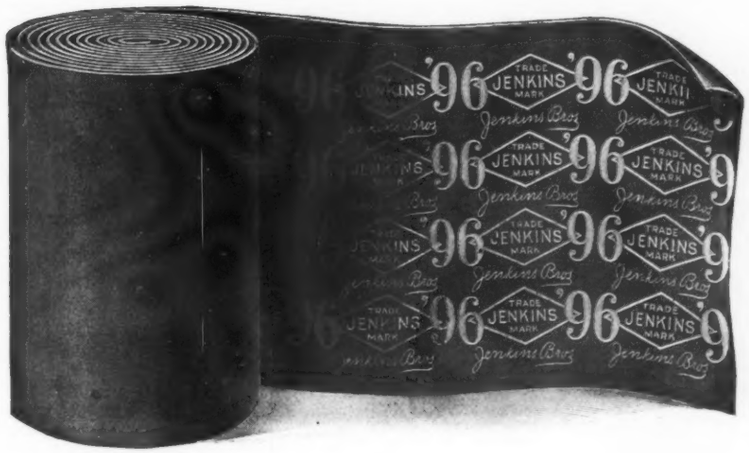

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There isn't any shoddy material in it just to give it costly but useless weight.

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Vol. I. **By James L. Robertson.** No. V.

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JAMES L. ROBERTSON

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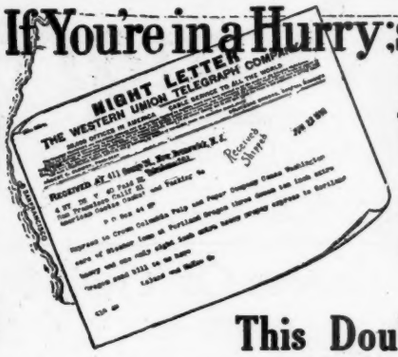

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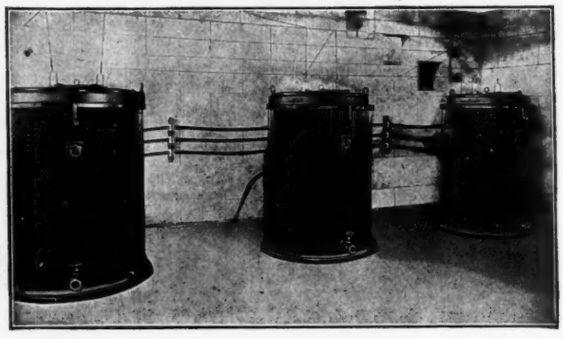

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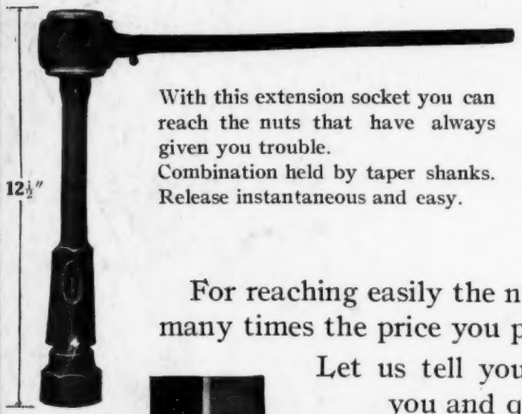

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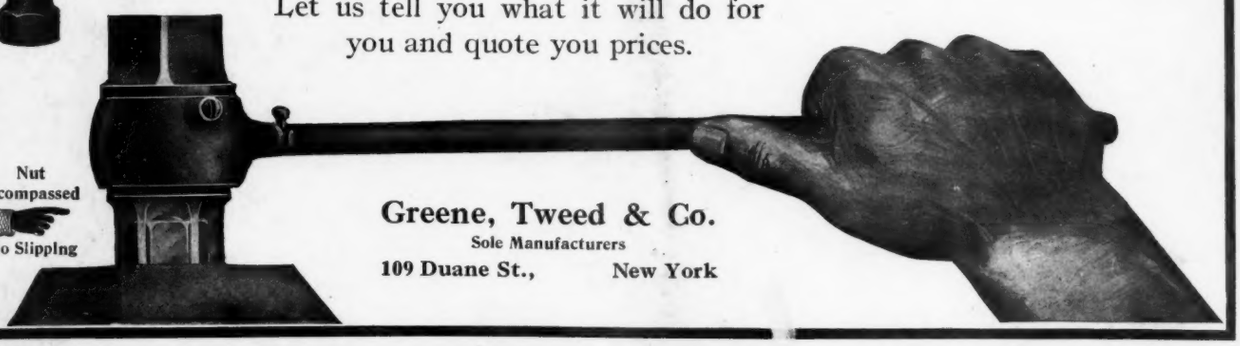

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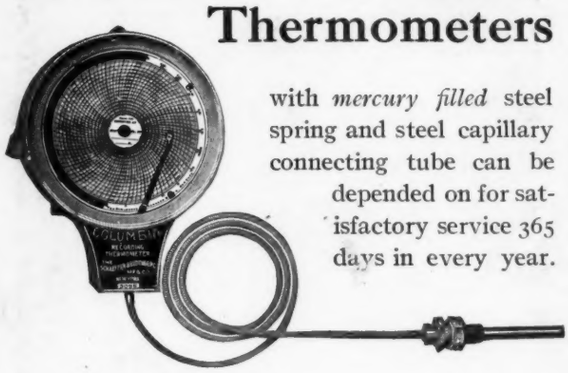

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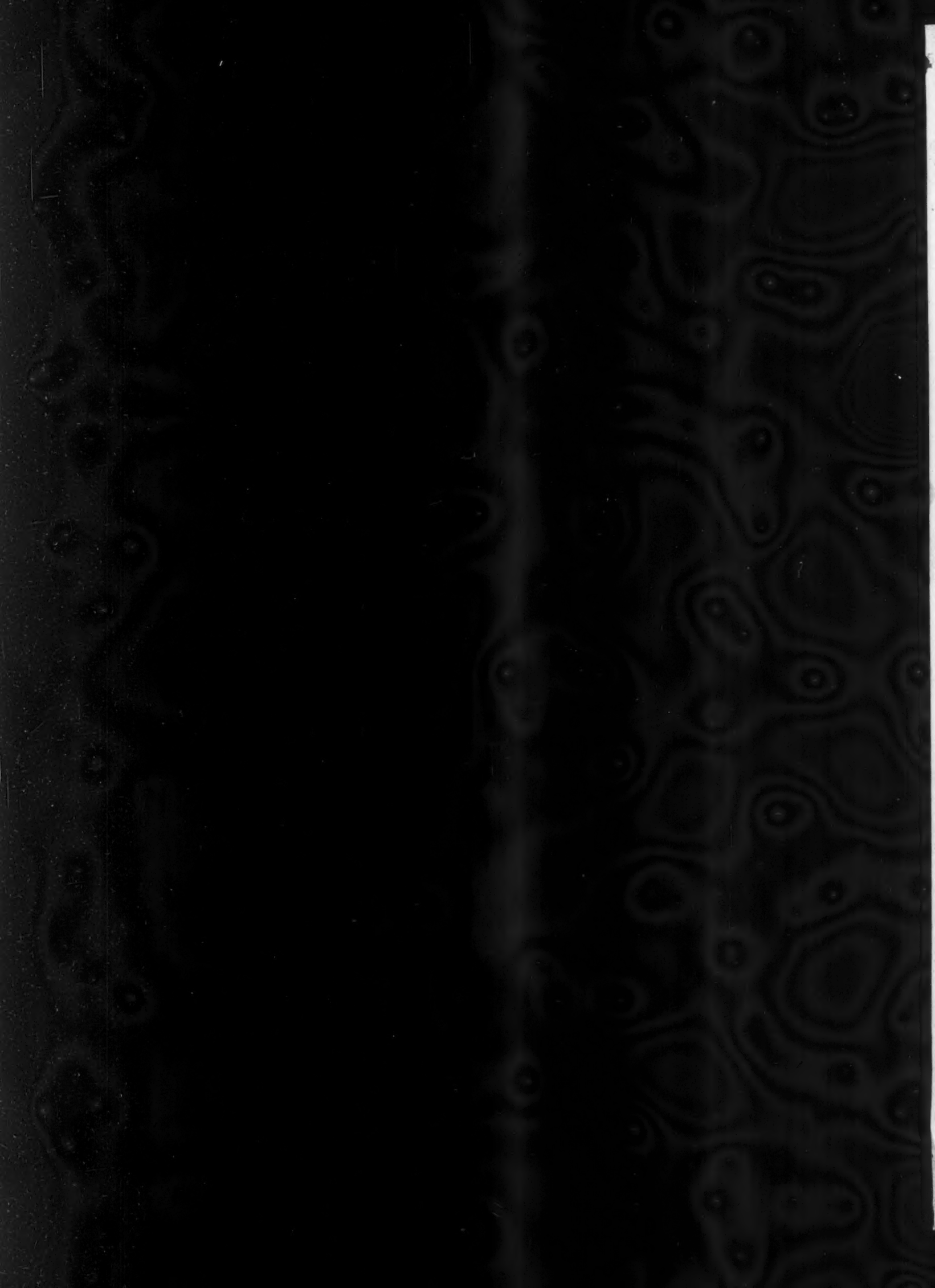
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